JOSSELYN VAN TYNE MEMORIAL LIBRARY
WILSON ORNITHOLOGICAL SOCIETY

THE CONDOR

Volume 61 November-December, 1959 Number 6

JOURNAL OF THE COOPER ORNITHOLOGICAL SOCIETY

THE CONDOR

JOURNAL OF THE COOPER ORNITHOLOGICAL SOCIETY

Published bi-monthly at Berkeley, California. Entered as second-class matter at the post office at Berkeley, California, May 15, 1925, under Act of Congress of March 3, 1879. Issued from the office of THE CONDOR, Museum of Vertebrate Zoology, Berkeley 4, California.

MANUSCRIPTS

Send manuscripts for publication to the Editor, ALDEN H. MILLER, Museum of Vertebrate Zoology, Berkeley 4, California, or to one of the Associate Editors, JOHN DAVIS or FRANK A. PITELKA, same address. Refer to suggestions on preparation of manuscripts for THE CONDOR on the back cover of recent issues of the journal.

SUBSCRIPTION RATES

Subscription price to non-members, five dollars per volume, payable in advance. Single copies, one dollar each.

MEMBERSHIP DUES

Regular members, four dollars per year in the United States, of which three dollars are for a year's subscription to The Condor; four dollars and twenty-five cents per year in all other countries in the International Postal Union.

Sustaining members, five dollars per year.

The life membership fee is one hundred dollars. No additional dues are required. The money is invested and the interest only is used for Society publications. Life members receive THE CONDOR without additional charge. Concerning memberships, address C. V. DUFF, 2911 Antelo View Drive, Los Angeles 24, California.

Send dues, subscriptions and notices of change of address to JACK C. VON BLOEKER, JR., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.

Send orders for back numbers of THE CONDOR and the PACIFIC COAST AVIFAUNA series to THOMAS R. HOWELL, Department of Zoology, University of California, Los Angeles 24, California.

Issued November 30, 1959

CONTENTS

PAGE

Behavior and Methods of Communication of Filleted Woodpeckers ..... *Lawrence Kilham* 377

Relation of Oxygen Consumption to Temperature in the Evening Grosbeak ..... *William R. Dawson* and *Harrison B. Tordoff* 388

Ecological and Distributional Relations of Desert Scrub Birds of Western Texas ..... *Keith L. Dixon* 397

Territoriality, Movements, and Population Density of the Dipper in Montana ..... *Gerald J. Bakus* 410

Body Temperature and the Ontogeny of Thermoregulation in the Slender-billed Shearwater ..... *Donald S. Farner* and *D. L. Serventy* 426

FROM FIELD AND STUDY

Cliff Swallows of Mixed Plumage Types in a Colony in Southeastern Arizona ..... *Horace H. Jeter* 434

The Barrow Goldeneye in Texas ..... *F. W. Miller* 434

Gila Woodpecker in San Diego County, California ..... *Leon L. Gardner* 435

Black-throated Sparrows in Northwestern Oregon ..... *H. M. Du Bois* 435

A Third Head-scratching Method of Emberizine Sparrows ..... *Jack P. Hailman* 435

Some Additional Records of the Skua from California ..... *Arnold Small* 437

Another Record of the Orchard Oriole in California ..... *Myrtle E. Johnson* 437

Occurrences of the Mockingbird at the Northwestern Margin of Its Range ..... *Ken Legg* 438

Changes in Winter Bird Species Composition of Two Habitats in San Miguel County, New Mexico, After Three-fourths of a Century ..... *W. H. Rickard* 438

NOTES AND NEWS 439

INDEX TO VOLUME 61 ..... *Jane R. Durham* 441

THE CONDOR

VOLUME 61 NOVEMBER-DECEMBER, 1959 NUMBER 6

BEHAVIOR AND METHODS OF COMMUNICATION OF PILEATED WOODPECKERS

By LAWRENCE KILHAM

The present study deals with displays, drummings and vocalizations of Pileated Woodpeckers (*Dryocopus pileatus*) together with descriptions of courtship, copulation, conflicts, territoriality and other situations with which these actions were associated. Much of this material has not been described previously as far as I am aware. Pileated Woodpeckers are not easy birds to observe the year around and this may explain why knowledge of their life history remains incomplete in spite of general accounts such as those of Bent (1939), Conway (1957) and Hoyt (1957).

Three situations have aided my investigations. First I had available a study area in a swamp by the Potomac River, near Seneca, Maryland, where, with the exception of two years, I could study the comparative behavior of woodpeckers since 1951. Second, these woodpeckers could be watched in an area in Florida where woods and swamps were free of undergrowth due to pasturage of cattle. I found that Pileated Woodpeckers were easy to approach in this pasture which I visited from February to May in 1958 and 1959 while studying at the Archbold Biological Station at Lake Placid in Highlands County. Finally, a hand-raised female Pileated Woodpecker enabled me to observe a number of aspects of behavior at close range.

METHODS OF COMMUNICATION

INSTRUMENTAL EXPRESSIONS

Drumming.—Pileated Woodpeckers drum in bursts which last for about 3 seconds and fall off toward the end. Bursts are commonly delivered at intervals of 40 to 60 seconds, 4 to 7 times in a row. The woodpeckers drum every month of the year in Maryland, but their drumming may consist of no more than a single burst in the late fall, given as a male happens to pass a drum tree. I have seen females drumming. They appear, however, to drum far less than the males. The drumming of Pileated Woodpeckers is frequently associated with preening and moments of excitement, as when the birds are about to roost for the night.

Drum-tapping.—Many species of woodpecker tap at a regular and countable rate in relation to courtship and the location of a nest hole (Blume, 1958; Kilham, 1958*b*, 1959*a*). Pileated Woodpeckers may tap in the manner of other woodpeckers at the time of nest relief. Members of a pair resort to a modified form of drumming when in apparent agreement on the site of a potential nest cavity earlier in the breeding season. This drum-tapping is a rapid roll which lasts for about a second. It may be repeated immediately. The head of the performing woodpecker appears to vibrate much as it does when pumping food into the throats of well-developed young. The drum-tapping may sound like a low *brr* if the wood of the nest site is soft. Descriptions of situations involving this performance are given in the section on behavior.

The European Black Woodpecker (*Dryocopus martius*) is the only generic relative of the Pileated Woodpecker on which information on behavior is available. Sielmann

(1958) has given excellent descriptions of the tapping of *D. martius* both at the time of nest excavation and at the time of relief on the nest. Eygenraam (1947) gives an exact description of what I have observed. He has used an old Dutch word "tockelen," which means strumming, for what I have termed "drum-tapping." Eygenraam, freely translated, states that Black Woodpeckers strum only against the edge of the nest hole or against the nest wall. Compared with pecking, the blows are weaker and the tempo is faster. A striking feature is the tense attitude of the bird while strumming. The neck is pulled in and the head is directed upward at an angle. The bill is lifted only slightly above the wood. Strumming occurs only during the nest building period. Eygenraam quotes Tinbergen as having made similar observations.

Rapping.—Pileated Woodpeckers strike a sharp rap with their bills against any surface they happen to be on, when nervous or excited. They frequently rap when approaching a roost hole in the presence of an observer. My captive bird would rap whenever I upset the aviary by dragging in fresh logs. Blume (1958) has described the rapping of *D. martius* and Tanner (1942) reported that the Ivory-billed Woodpecker (*Campephilus principalis*) gave a double rap—*bam, bam*—when disturbed.

VOCALIZATIONS

Random cuks.—These are the most frequent vocalizations of Pileated Woodpeckers. They can be given at a rate of four *cuks* a minute for some minutes, but they are usually delivered in a slower, more irregular manner. Variations can make it possible for a single bird to sound like a pair of woodpeckers or even a domestic fowl. Random *cuks* appear to have a number of functions. They may serve to maintain the pair bond the year around and to register excitement in addition to location. A lone, unmated male in Seneca Swamp resembled my captive female in giving almost no random *cuks*.

High call.—This vocalization has a regular pattern of 6 to 8 high-pitched *cuks* with a terminal one of lower pitch. High calls are the main breeding notes of Pileated Woodpeckers and they also appear to express dominance within an area. My captive female gave almost no high calls until placed in an outdoor cage in New Hampshire where she could hear wild Pileated Woodpeckers in the adjacent woods.

Woick, woick.—These are intimate notes exchanged by members of a pair in the breeding season and I have heard them as late as mid-September. *Woicks* almost invariably accompany the bill-waving dance described later.

G-waick, g-waick.—These were loud, shrill vocalizations which I have heard most frequently when a pair of Pileated Woodpeckers encounters a rival individual or another pair. Courtship and conflict seem to elicite somewhat similar expressions, for *g-waicks* may be exchanged when a pair appears to be alone. It is possible that *g-waicks* represent *woicks* given at a high intensity. Situations attending both vocalizations are illustrated in figure 4.

Hn, hn.—These low, grunting noises are intimate notes made during the breeding season. I am not sure whether these notes are exchanged since it is difficult to determine which bird is making vocalizations when a pair is close together. The note is definitely made by females and is identical with the begging call of well-developed young. These vocalizations are sometimes drawn out into a *hn-waan,* which is suggestive of a gray squirrel (*Sciurus carolinensis*).

Notes of nestlings.—Nestling Pileated Woodpeckers have vocalizations which have no obvious relation to anything expressed by adults. On April 30, 1958, for example, I heard soft *churr, churr* notes when I stood below a nest in Florida. The vocalizations were given intermittently. I removed the young from the nest on the same day, estimating that they were from 11 to 12 days of age. The two nestlings lived in an artificial

hollow for the next eight days. They would crawl to the top when hungry, feed from my fingers, then drop to the bottom to make a variety of soft jabber noises. They also made *peep, peep, peep* vocalizations when settling for the night.

DISPLAYS

Full-wing threat display.—A Pileated Woodpecker may face an adversary with wings stretched out sideways (fig. 4), a performance which flashes the white of the under wings in contrast with the black of the body.

Fig. 1. Pine pasture habitat of Pileated Woodpeckers in Florida.

Bill-waving dance.—In this display a Pileated Woodpecker points its head and bill straight upward and even backward, while jerking them about, swaying the body and making intention motions with its wings. I have never seen this dance without hearing the *woick, woick* vocalization at the same time.

It would appear from the sketches and descriptions of Blume (1956) that the European Black Woodpecker has a bill-waving dance similar to that of *D. pileatus*, the difference being that the accompanying vocalization is *rurr* instead of *woick*. The flicker (*Colaptes auratus*) and the Hairy (*Dendrocopos villosus*) and Downy (*D. pubescens*) woodpeckers also have bill-waving dances, as mentioned by Bent (1939) and as I have observed in field and aviary studies.

Raising of crest.—Pileated Woodpeckers raise the long, red feathers of their crests straight upward when excited. This action usually accompanies the other types of display.

BEHAVIOR

EARLY BREEDING SEASON

I observed the courtship, copulation, drum-tapping, and conflicts with rivals of one pair of Pileated Woodpeckers in Florida between March 1 and 5, 1959. This was at a time when the birds were leaving one nest excavation to select a site for a new one.

Copulation.—The four occasions on which copulation was observed in Florida were as follows: (1) Male A had drummed 7 times in 5 minutes at 4 p.m. on March 3, when his mate flew to him giving random *cuks* on the way. She alighted crosswise on a dead limb. The male did a bill-waving dance calling *woick, woick*. I also heard *hn, hn* vocalizations. The male mounted the female and copulation took place; after he had left, his mate remained, preening her spread and uptilted tail. (2) The male returned to the same pine a half hour later and drummed 6 or 7 bursts. When his mate flew toward him, he flew out as if to meet her, then passed over my head. She alighted on the dead pine and drummed one burst. He returned immediately. There was an exchange of *woicks* as the female moved out onto a limb. The male mounted but I could not determine whether copulation had taken place. (3) At 8:40 a.m. on the following day I had a more complete view of copulation when the female alighted near the male. An exchange of *woicks* followed. She was again crouching crosswise on a limb when he flew over and mounted her back firmly. He then fell backward and over to the left in a gradual and awkward fashion in what appeared to be close cloacal contact. This process took an appreciable time. The female

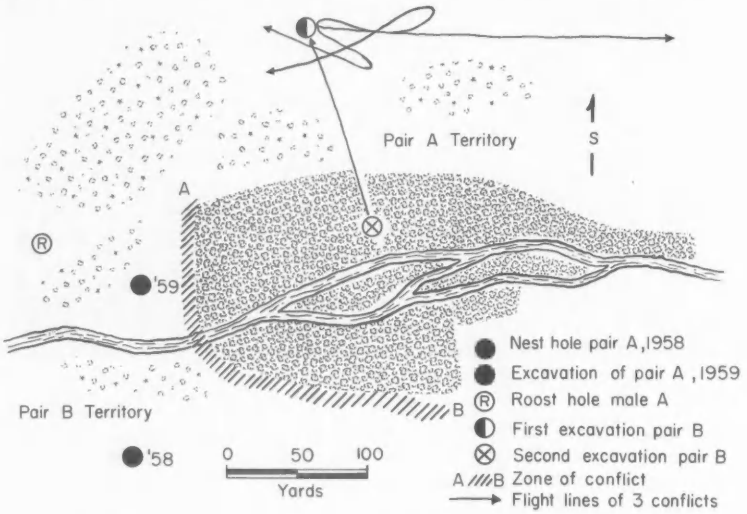


Fig. 2. Territories of two pairs of Pileated Woodpeckers in Florida. Boundaries indicated by zones of conflict.

presented an odd spectacle after he had left, for her head and tail were drooping limply over either side of the limb and her body was flattened closely against it. (4) An hour later pair A had just driven away a rival pair and were flying back when the female alighted crosswise on a dead pine limb. Her mate mounted but came off right away in what might be termed pseudo-copulation.

I have also observed copulation of Pileated Woodpeckers in Maryland. All three occasions were in March; one on March 22, 1957, at 7:15 a.m. and the other two on the evenings of March 25 and 31, 1959, at a time when a pair had just completed their nest excavation. No references known to me give any description of copulation among Pileated Woodpeckers.

Beginning of excavations and drum-taps.—On March 1 and 2 I watched the male and female of pair A excavating at separate times in a pine stub located on the periphery of their territory (fig. 2). The stub was remarkable. It was 70 feet tall and contained 11 holes, of which the top 5 were obviously old. The most dilapidated of these was the roost hole of female A. There were 6 fresh excavations within a length of 15 feet in the lower part of the stub (fig. 3). As far as I could determine the Pileated Woodpeckers had made successful entrances to these 6 fresh holes but had been stopped, on each attempt, by the hard inner core of the pine. This was the reason, I presumed, for their seeking another site for locating a nest hole.

After copulation by pair A on March 3 the male flew into the adjacent swamp followed by his mate. I was unable to keep them in view. I did, however, hear *hn, hn* vocalizations and a series of double drum-taps which, although delivered on a resonant spot, were unlike the lengthy roll of a regular drumming. Subsequent events suggested that pair A was starting a new excavation at about this time. Thus at 9:40 a.m. on the following day I located male A as he was excavating a hole 1½ inches wide and equally deep, 40 feet up in a dead stub arising from the swamp water. This stub was in the same area where I had heard drum-tapping the day before. The female arrived with some *hn, hn* noises and I saw the male give three bursts of drum-taps, all delivered at the edge of the excavation. Both sexes excavated. The hole enlarged rapidly during the day, for when I returned at 2:40 p.m. the entrance was already of full size. A little later female A made a series of random *cuks* as she flew to the excavation. Her mate immediately put his head inside the hole and I could see that he was drum-tapping by the vibration of his crest as well as by the peculiar position of his head. She then drum-tapped on the outside. The male flew away. His mate excavated for 3 minutes and when he reappeared, she drum-tapped inside the hole just as he had done on the previous change-over. Each of the birds did a half-hour stretch of excavating during the afternoon. The male was getting much of his body into the excavation by 4:15 p.m., but there were indications that he was losing enthusiasm. For example, he had not drum-tapped during the afternoon change-overs although his mate had done so on each occasion. This loss of interest became obvious over the next two days. On March 6, male A rested at the hole for 20 minutes but excavated for only 30 seconds. His mate arrived, drum-tapped, then worked at the hole for 50 minutes.

I observed pair B, which occupied a territory adjacent to that of pair A in Florida, excavating in February, 1958, and in March, 1959. In each year the nest cavity was in the rotted tops of pine stubs. One or the other of the pair might excavate, but at well separated intervals; there were no direct change-overs, no drum-tappings, and the male did most of the excavating in both years.

TERRITORIALITY

Pairs of Pileated Woodpeckers appear to occupy the same areas year after year. One can hardly refer to such areas as territories when distances in swampy and wooded country, such as those in my study area in Maryland, make it difficult to follow a Pileated Woodpecker in a regular manner. The drumming territory of an unmated male in Seneca Swamp was an exception which is described in the following section. The situation in Florida was different, for I was able to follow the activities of Pileated Woodpeckers for hours at a time. The pasture where observations were made consisted of two zones well demarcated from each other: one of pine glades with patches of grass and saw palmetto, the other of dark wooded swamp along a winding creek. The juncture of swamp and pine glades was the boundary between the territories of pairs A and B (fig. 2) as was apparent from five encounters which I witnessed in this area as well as from the fact

that neither pair fed in the territory of the other. The encounters were mild and took place late in afternoons. Thus on 4 out of 7 evenings between February 1 and 7, 1958, both pairs approached the border zone making shrill *g-waick, g-waick* vocalizations which I did not hear from either pair at other times of day. On March 4, 1959, I had an especially close view of what took place on these occasions. At 5 p.m. female A gave a high call in response to one from her mate and flew to him at the edge of the swamp. Pair B, possibly hearing these calls, flew to the same area. I now saw one or the other bird of opposite pairs flying toward each other over an open space, alighting on separate trees as they made *g-waick* vocalizations. These calls ceased when pair A flew back into the swamp.

Fig. 3. Pine stub with many holes excavated by Pileated Woodpeckers in Florida.

Intrusions of a third pair of Pileated Woodpeckers and conflicts which they had with pair A indicated that these latter birds were also defending a territorial boundary to the south (fig. 2). The intrusions probably originated because of a scarcity of suitable nest trees, for all of the three conflicts observed were related to the many-holed pine stub described previously. The following details were among those observed: (1) The intruding male had excavated at the pine stub for 10 minutes on the afternoon of March 2, 1959, when male A swooped down on him from the top of the stub and the two grappled in the air. Male A excavated briefly. He then flew at the intruder which was resting 60 feet away but now took a long flight away from the area. (2) Both members of pair A were on the pine stub at 8:30 on the following morning when the intruding male gave a high call 250 yards to the east. Male A immediately flew toward the intruder, followed by his mate. One male pursued the other several times in a circuit up a dead pine and the two grappled in the air before the intruding male took a long flight in the same direction as on the previous day. (3) The four members of the two pairs of Pileated Woodpeckers had a conflict on March 4. Pair A was at its new excavation in the swamp when an

intruding Pileated Woodpecker drummed one burst near the south boundary (fig. 2). Female A flew toward the sound immediately, followed by her mate, and the two were by their many-holed pine stub before I was able to view them again. From this resting place female A, and then her mate, drove away a female rival from trees 50 feet away. All the conflicts described above were direct attacks, unaccompanied by displays or vocalizations.

ACTIONS OF AN UNMATED MALE

The behavior of a lone male (LM) in Seneca Swamp, Maryland, illustrated a different type of territoriality from that just described, for it was associated with efforts of an unmated Pileated Woodpecker to attract a mate. I came to this interpretation after eleven mornings of observation between December 25, 1957, and March 2, 1958. In this period I never saw LM in association with any other Pileated Woodpecker and his behavior in regard to drumming and vocalizations was markedly different from that of a mated male in an adjacent area.

LM made rounds of the same drumming trees on successive days. It was not difficult to follow him over the frozen swamp when trees were bare of leaves, especially since his long flights were usually above the treetops and his persistent drumming made him easy to locate. The distance between the extremes of his drumming trees was 700 yards. His drumming territory remained the same for more than two months. Irregularities of terrain prevented any significant determination of its width.

There was a marked increase in the drumming of Pileated Woodpeckers in Seneca Swamp at the end of December. Most of this drumming was done by LM. On January 12 this male drummed continuously for 3 hours from the time I first heard him at 7:20 a.m. At 8:30 he was drumming, at his usual rate of one burst every 25 seconds, on an oak stub where an old woodpecker cavity gave added resonance. LM took a long flight to the other end of his territory. He soon returned, giving high calls on the way, and from 8:50 until 9:30 he drummed, almost without interruption, on three different trees. The neighboring male, a mated Pileated Woodpecker, drummed for 5 minutes at about 8 a.m. and did no further drumming as far as I was aware. His rate was one burst every 40 to 60 seconds.

LM gave many high calls but infrequent random *cuks* were heard in comparison with the situation in the neighboring male. LM gave his high calls, in most instances, when about to fly from one drum tree to another or when on a long flight across his territory. The only other vocalizations were shrill *g-waicks*. They all came from the lower end of LM's territory which was the one place where he would have been most likely to have encountered the neighboring pair of Pileated Woodpeckers. Unfortunately I could never get a good view of the actual situation because of intervening trees.

ACTIONS ASSOCIATED WITH ROOSTING

A pair of Pileated Woodpeckers had roost holes 80 yards apart by the Potomac. The male's hollow was freshly excavated in October, 1958, and he continued to occupy it until the next spring when he took to roosting in a new nest excavation which the pair had made in the vicinity of their winter roost holes. An extra male Pileated Woodpecker roosted in the same area.

I had evidence that conflicts took place between the two males on at least nine evenings between September 24 and March 31. One of the more spectacular conflicts occurred at about 4:20 p.m. on December 13, 1958, when the Pileated Woodpeckers flew to the base of a tree 30 paces from where I stood. They shifted around the trunk as one tried to strike down at the other. The male on the defensive raised his wings in full threat display. This silent conflict was interrupted when a female (F1) flew to the base of the tree

making shrill *g-waick* vocalizations as she did so. One of the males made the same noises. The three Pileated Woodpeckers were now close together and the male and female on either side were engaging in a bill-waving dance, accompanied by *woicks*, when the male in the middle suddenly raised his wings in a full threat display (fig. 4). There was a flurry of wings, the female departed and the males resumed their silent conflict.

A different type of conflict took place at dawn on January 10, 1959. Male M1 flew from his roost hole at 7:21 a.m. Within a few minutes female F1 and male M2 had come to a tree behind me and M1 immediately flew toward them and over my head, calling *woick, woick, woick* as he flew. One of the woodpeckers on the tree did a bill-waving

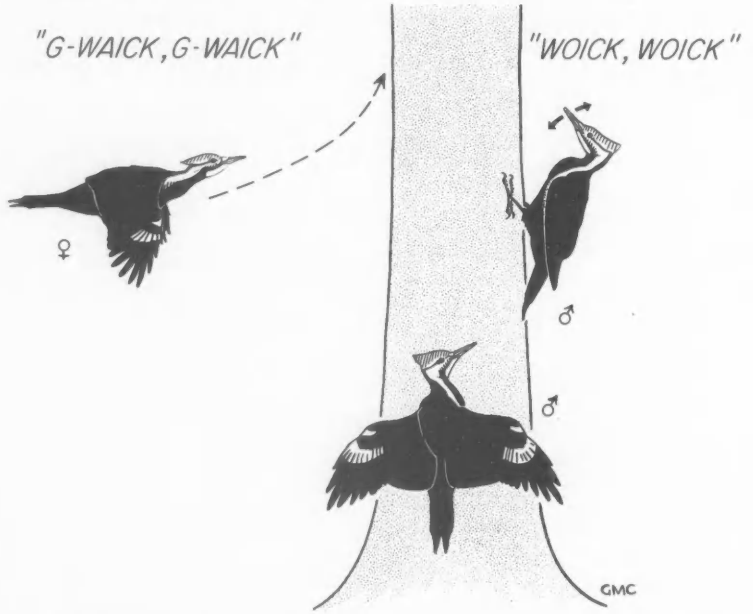


Fig. 4. Conflict between two male Pileated Woodpeckers observed on December 13, 1958. Male in center performed a full wing threat display and male to right did a bill-waving dance when his mate flew in from left.

dance. The three birds now flew away, F1 to feed on a stump with seeming indifference while the two males fought for the next 20 minutes in her vicinity. One male would alight below his rival, then chase him up the tree trunk to the upper branches. The fleeing male flapped his wings as if to speed his ascent. He would then take flight and a pursuit would follow, round about through the woods until the two males had alighted on another tree. The male being pursued took rest in a curious way on several occasions. He would alight on small branches of low trees, clinging upside down as I have seen Pileated Woodpeckers do when feeding on poison ivy berries, but this male was not feeding. He preened in a nervous fashion but was not attacked until he flew to a tree trunk.

The Pileated Woodpeckers roosting by the Potomac sometimes flew down to the water to drink before entering their holes for the night. I had close views of this drinking

on four occasions. On March 22, F1 flew to the base of a sycamore at 6 p.m., then moved along its roots to the edge of a creek where she dipped her bill in the water, then raised her head nine times. The male behaved in similar fashion three days later, dipping his bill into the water 14 times before flying to his roost hole.

On February 25 I witnessed the beginning of some interesting competition between the woodpeckers and a pair of nesting Wood Ducks (*Aix sponsa*). It was evening when I noticed that female F1 was behaving in a singular fashion. She kept peering into her roost hole, then drew back and flew to a neighboring branchlet where she would hang upside down and sway momentarily before returning to peer again. She repeated these performances five times before flying away to roost elsewhere. F1 behaved in an identical manner on the evening of March 22. It was at this time that I discovered that a female Wood Duck was entering the same hollow sycamore by an entrance three feet below the hole used by the woodpecker. As in encounters which I have observed between Pileated Woodpeckers and other animals (Kilham, 1958*a* and 1959*b*), the woodpecker remained almost completely silent.

CAPTIVE FEMALE

A hand-raised female Pileated Woodpecker (fig. 5) was kept in an indoor garage which had been converted into an aviary 10½ feet square by 7½ feet high. Five other woodpeckers lived in the same aviary. These other hand-raised species included a pair of Yellow-shafted Flickers (*Colaptes auratus*), two female Red-bellied Woodpeckers (*Centurus carolinus*) and a female Yellow-bellied Sapsucker (*Sphyrapicus varius*). The Pileated Woodpecker responded to these associates in various ways, partly, one may presume, through lack of any companion of her own species. Her displays in relation to the sapsucker were of particular interest. They consisted of bill-waving dances accompanied by *woicks* and these took place many times a day when the sapsucker happened to fly near to the Pileated Woodpecker and *vice versa*. The Pileated Woodpecker did not perform in this fashion to any of the other birds in the aviary. The dances had been going on for nearly two months when I removed the sapsucker, by way of an experiment, on October 15. The Pileated Woodpecker came to the wire closest to the cage containing the sapsucker and did a *woick* dance. I then removed the cage to another room for three days. There were no bill-waving dances in this period, but when I returned the sapsucker to the aviary on October 18, the Pileated Woodpecker immediately followed it about and at the same time performed the longest series of bill-waving dances which I had observed. The sapsucker never responded in any way on this or on other occasions. One can only conjecture why the Pileated Woodpecker sought out this particular companion from among the woodpeckers present. Female Yellow-bellied Sapsuckers, however, do resemble miniature male Pileated Woodpeckers in having a red frontal patch which can be raised into a crest, a white throat ending in black on the breast and a number of black and white lines radiating backward from the base of the bill. This combination of markings may have served as releasers. Pileated Woodpeckers are closely paired the year around and my lone female probably felt the lack of a mate, a lack which found expression in her displays to the one bird which most resembled a male of her own species.

The Pileated Woodpecker resorted to full-wing threat displays on only a few occasions, one of which was in November when she began to spend her first nights in a roost box and became aggressive toward one of the Red-bellied Woodpeckers. She pursued the smaller bird about the aviary in a most persistent fashion. The Pileated would raise her crest and spread her wings whenever able to get at all close and at one time, when the Red-bellied Woodpecker was feeding from my fingers, she flew up and gave a full threat display within a few feet of my face.

The Pileated Woodpecker had a form of play which took place over many months when I turned on the aviary lights in the morning. She would cling to the under side of a slanting log, her crest raised and bill pointed upward as she made intention motions with her wings; she then shifted nimbly from one side of the log to the other as if dodging an imaginary assailant.

Fig. 5. The hand-raised female Pileated Woodpecker when six months of age.

SUMMARY AND CONCLUSIONS

Pileated Woodpeckers (*Dryocopus pileatus*) were found to drum throughout the year. The females drum but do so infrequently in comparison with males. Drumming serves various purposes, of which advertisement of dominance within a territory and attraction of a mate are of particular importance. The breeding or high call is used in somewhat the same manner as drumming and also has great carrying power.

These woodpeckers have a peculiar method of drumming which serves to register agreement between members of a pair on the location of a nest site. It is thus analogous to the tapping of some other species of woodpeckers.

An unmated male drummed persistently for over two months in mid-winter, using the same round of drum trees. His drumming territory was 700 yards long.

Pileated Woodpeckers also rap with their bills, making a sharp *bam,* when nervous.

Random *cuks* are the most frequent vocalizations and serve as location notes in keeping members of a pair together. They may also act as alarm calls when given at high intensity.

Pileated Woodpeckers have intimate vocalizations which serve to maintain the pair bond and are heard most frequently in winter and spring. One of them, a ***hn, hn*** note, is identical with the begging call of fully fledged young.

Pileated Woodpeckers may extend their wings sideways in a threat display when facing an adversary of their own or of unrelated species.

A bill-waving dance is an expression of intimacy between members of a pair. It is accompanied by a ***woick, woick*** vocalization.

The Pileated and the related Black Woodpecker share many similar habits which include tapping, drum-tapping, rapping, and the bill-waving dance.

The female may invite copulation by flying to the male and squatting crosswise on a limb. Seven instances of copulation were observed in March.

The roosting habits of one pair of Pileated Woodpeckers were followed from September until March, when a nest hole was completed. An extra male roosted in the same vicinity and conflicts between the two males took place intermittently over a 6-month period. The woodpeckers often flew down to a river bank to drink in the evening, just before flying to their roost holes. A female Wood Duck disturbed the female woodpecker by occupying a cavity three feet below her roost.

Territoriality, as evidenced by conflicts along boundaries, was observed in two pairs of Pileated Woodpeckers in Florida.

LITERATURE CITED

Bent, A. C.
1939. Life histories of North American woodpeckers. U. S. Nat. Mus. Bull. 174.

Blume, D.
1956. Verhaltensstudien an Schwarzspechten (*Dryocopus martius*). Vogelwelt, 77:129–151.
1958. Uber die instrumentalen Lautausserungen bei Schwarzspecht, Grunspecht, Grauspecht und Buntspecht. Vogelring, 27:65–74.

Conway, W. G.
1957. Pileated woodpecker king of the woods. Animal Kingdom, 60:52–58.

Eygenraam, J. A.
1947. Het gedrag van de Zwarte specht, *Dryocopus m. martius* (L.). Ardea, 35:1–44.

Hoyt, S. F.
1957. The ecology of the pileated woodpecker. Ecol., 38:246–256.

Kilham, L.
1958*a*. Repeated attacks by a sharp-shinned hawk on a pileated woodpecker. Condor, 60:141.
1958*b*. Pair formation, mutual tapping and nest hole selection of red-bellied woodpeckers. Auk, 75:318–329.
1959*a*. Mutual tapping of the red-headed woodpecker. Auk, 76:235–236.
1959*b*. Pilot black snake and nesting pileated woodpeckers. Wilson Bull., 71:191.

Sielmann, H.
1958. Das Jahr mit den Spechten (Verlag Ullstein, Berlin).

Tanner, J. T.
1942. The ivory-billed woodpecker. Nat. Aud. Soc. Research Report No. 1

Bethesda, Maryland, May 20, 1959.

RELATION OF OXYGEN CONSUMPTION TO TEMPERATURE IN THE EVENING GROSBEAK

By WILLIAM R. DAWSON and HARRISON B. TORDOFF

*Information now at hand indicates that most larger birds and mammals living in cold climates have adapted to them through extensive capacities for heat conservation. These capacities permit the animals to maintain body temperatures at normal levels with a minimal rate of heat production even under extreme conditions (Scholander, 1955). This economical mode of climatic adaptation does not appear to have been utilized by small birds (Scholander *et al.*, 1950*b*; Dawson, 1958), but information is limited on physiological responses of species which actually encounter severe and prolonged cold weather in nature. Therefore, we welcomed an opportunity to study the eastern race of the Evening Grosbeak (*Hesperiphona vespertina vespertina*), which winters in cold climates. Our studies of this species permit definition of its basal metabolic rate and lower limit of thermal neutrality, comment upon its temperature regulation in cold environments, and consideration of the bioenergetic problems which confront it and other small birds in winter.*

ACKNOWLEDGMENTS

We are grateful to Nicholas L. Cuthbert for supplying us with 20 Evening Grosbeaks freshly trapped at his banding station near Mount Pleasant, Isabella County, Michigan, during February, 1958. Our study on these birds was supported in part by grants from the National Science Foundation (G–2096) and from the Horace H. Rackham School of Graduate Studies, The University of Michigan.

MATERIALS AND METHODS

Birds of the eastern race of the Evening Grosbeak breed from northern Alberta and New Brunswick south to central Alberta, Canada, and the northern parts of Minnesota, Michigan, New York, and New England. They winter throughout the breeding range and, sporadically, south to Kansas, Arkansas, Tennessee, and the Carolinas. Although nesting in northern regions in which coniferous forests predominate, the Evening Grosbeak is much less closely associated with conifers than are some other members of its group, the subfamily Carduelinae. A variety of trees, including hardwoods, are used for nesting sites. Important food plants include, in addition to conifers, various wild cherries (*Prunus*), box elder (*Acer negundo*), and many other kinds of deciduous trees and herbaceous seed-bearing plants.

Metabolic measurements were made on 16 birds—7 males and 9 females—between February 24 and April 5, 1958. During this period the birds, when they were not being used in experiments, were housed outside in a large flight cage measuring 6×6×9 feet or in a smaller one measuring 2×4×6 feet. The grosbeaks were provided with snow or water for drinking and with food consisting of sunflower seeds and chicken scratch. The birds maintained their weight or became slightly heavier while in captivity. All except those purposely sacrificed were in excellent condition when released six months after capture.

The measurements of oxygen consumption reported here were made at night on resting birds that had been without food for at least three hours. An open circuit system was used in which air from a low pressure line passed successively, via tygon tubing connections, through a drying train of "Drierite" (anhydrous $CaSO_4$), a darkened metabolism chamber in which the animal rested, a second train containing a carbon dioxide absorbent

("Ascarite") as well as Drierite, a flow meter, and, finally, a Beckman paramagnetic oxygen analyzer (Model F–2). This analyzer was equipped with a multiple sampling system which allowed use of up to 3 metabolism circuits simultaneously. The metabolism chambers were fashioned from new, one gallon paint cans by two simple modifications: horizontal platforms of ½-inch wire mesh on which the birds could perch during the experiments were placed inside the cans, 3 cm. from the bottom; the airtight lids of these cans were equipped with fittings for tygon tubing connections and with a housing for a thermometer.

The rate of air flow through this open circuit system was approximately 550 cc./min. (not corrected to standard conditions of temperature and pressure), and the pressure in the chamber was about 12 mm. Hg above atmospheric pressure, thus approximating 750 mm. Hg absolute pressure during most of the experiments. The rate of air flow was generally adequate to maintain the oxygen and carbon dioxide levels above 20 and below one per cent, respectively. It also kept the relative humidity below 40 per cent at experimental temperatures above 20°C. Temperature within the chambers was maintained within 0.2°C. of the desired level by keeping them in a 17 cu. ft. constant-temperature cabinet for experiments conducted above 0°C. or in a freezer for those below that temperature.

True rates of oxygen consumption by the birds were computed with the method described by Depocas and Hart (1957) for the above type of metabolism system. All gas volumes specified for metabolism have been corrected to standard conditions of temperature and pressure (0°C. and 760 mm. Hg).

The oxygen analyzer was used in conjunction with a recording potentiometer, so that a continuous record of the fractional concentration of oxygen in the air leaving the metabolism chamber could be obtained. This record was useful in the detection of restlessness and in the determination of the time at which metabolic rate had declined to a minimal level for the particular experiment.

A few measurements of respiratory quotient (RQ) were made at the close of metabolism experiments with a method outlined by Peters and Van Slyke (1946). Data on body temperature reported in this paper were obtained with copper-constantan thermocouples fashioned from 30 gauge duplex wire. Those thermocouples employed for determination of deep body temperature were inserted through the cloaca into the large intestine. They were held in place by fastening the lead wires to the tail feathers with stiff paper and staples. The thermocouples used to obtain subcutaneous temperatures were initially fitted with lead wires only a few inches long. One of these wires was threaded through a needle and then sewn through the skin on the breast in such a manner that the thermocouple junction was brought beneath one of the ventral feather tracts. The lead wires were then bent so that the junction was immobilized at the desired position. These wires were then connected to the appropriate sides of a longer duplex lead. This duplex lead was anchored to the dorsal feather tract with thread. The bird with its two thermocouples in position was then placed in a small screen cage in which it could stand but neither move forward or backward, nor turn around. This cage could then be placed in a darkened freezing compartment and the skin and body temperatures of the bird followed during the several hours of the experiment.

RESULTS

Oxygen consumption.—The relation of oxygen consumption of the Evening Grosbeak during winter and early spring to environmental temperature is illustrated in figure 1. The basal metabolic rate (BMR) of this bird—taken as the mean of the data for temperatures between 20°C. and 31°C., a range lying well within the zone of thermal

neutrality (see following)—is 2.5 cc. O_2/gm./hr. ($\sigma = 0.23$) at this time of year. The lower limit of thermal neutrality ("lower critical temperature"), which we have defined as the temperature at which the line fitted to the points between −16° and +10°C. reaches the level of 2.5 cc. O_2/gm./hr. (the BMR), is 16°C. Therefore the zone of thermal neutrality for this species is at least 18°C. wide, extending from 16°C. to at least 34°C., the highest temperature at which measurements were made.

As shown in the figure, the line fitted to the points between −16°C. and +10°C. extrapolates to zero oxygen consumption at 41°C., a temperature lying within the normal range of body temperature for this species. We shall subsequently discuss the implications of this fact. The essentially linear, inverse relation which exists between oxygen consumption and environmental temperature at temperatures between −16°C. and approximately +12°C., seems to give way to a curvilinear relation in the vicinity of 16°C. which we have defined as the lower critical temperature. This suggests that the transition

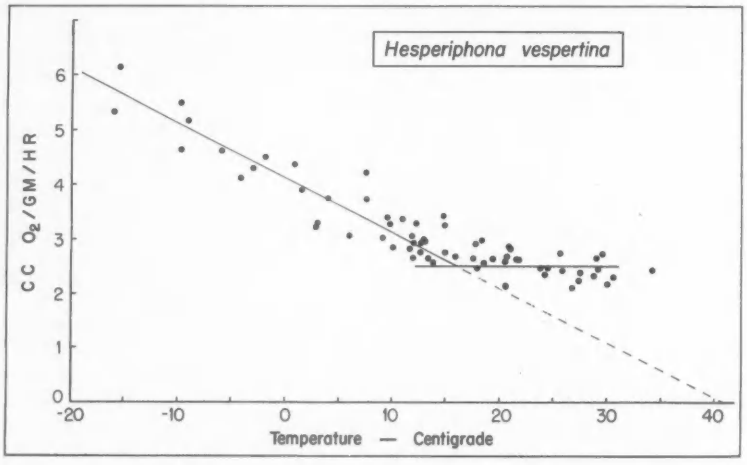


Fig. 1. The relation of oxygen consumption to environmental temperature in the Evening Grosbeak between late February and early April.

from regulation of body temperature primarily through control of heat loss to regulation through adjustment of heat production occurs over a range of several degrees of environmental temperature, rather than abruptly at a single temperature. This also appears to be true in the Cardinal, *Richmondena cardinalis* (Dawson, 1958), and in some other species discussed by Scholander *et al.* (1950*b*:253). It makes the designation of a single value for the lower critical temperature somewhat an abstraction, but it is a useful one from a theoretical standpoint. It was because of this apparent departure from linearity in the vicinity of the lower critical temperature that data for temperatures above 10°C. were not used in fitting the regression line referred to above.

Respiratory quotient of fasting birds.—The respiratory quotient (RQ) was determined for six Evening Grosbeaks that had fasted at temperatures between 25°C. and 27°C. for 3 to 12 hours, to facilitate selection of a proper caloric equivalent for oxygen for use in certain calculations presented in the subsequent section of this report. It was

assumed that the RQ of fasting animals would be independent of temperature except in warm environments. This assumption appears justified on the basis of Irving *et al.*'s (1955) measurements on the Northwestern Crow (*Corvus caurinus*). The mean RQ for the grosbeaks uncorrected for protein metabolism is 0.735 (σ=0.039). The value obtained for one bird, 0.66, was much lower than those for the others, which were all above 0.70. This low value does not appear to be an artifact as it was checked twice. According to King (1957), RQ's between 0.65 and 0.71 are normal and fairly common in birds fasting under experimental conditions. As a result of the mean value obtained for the RQ, a caloric equivalent of 4.7 cal./cc. O_2 will be used in the subsequent calculations.

Body temperatures.—Measurements of skin temperature were made on four birds at the conclusion of experiments on oxygen consumption, by placing a fine thermocouple on one of the ventral feather tracts just as the animal was removed from the metabolism chamber. These indicated skin temperature to be relatively uniform, ranging between 35.5°C. and 38°C. at environmental temperatures from 15.8°C. down to −13.6°C. The results of two experiments in which implanted thermocouples were employed on birds confined within a wire cage in a freezing compartment also indicated skin temperature to be maintained at a high level in the cold. During an exposure of 4 hours to −8°C., one of these individuals maintained body temperature at 40.6°C. and skin temperature between 39.3°C. and 38.4°C. During an exposure of 2 hours to −12.9°C., a second bird maintained body temperature between 40.8°C. and 41.5°C. and skin temperature between 38.0°C. and 39.6°C. The somewhat higher values noted here probably reflect the fact that in these two instances the thermocouples were beneath the skin, whereas in those four cases mentioned above they were in contact with its outer surface. The maintenance of skin temperature at a high level over a wide range of environmental conditions suggests that the plumage is the major instrument of insulation for the main portion of the body in Evening Grosbeaks.

DISCUSSION

Basal metabolism.—The value obtained for the BMR of the Evening Grosbeak during winter and early spring, 2.5 cc. O_2/gm./hr., is in close agreement with the few other values available for passerine birds in the same size range (50–65 gm.) and with that predicted by Brody's equation relating BMR to body weight in birds generally (Brody, 1945; Scholander *et al.*, 1950*a*; Dawson, unpublished observations). This suggests that the adjustment of this boreal species to winter conditions does not entail elevation of the BMR, although measurements at other seasons are necessary to resolve this conclusively. The scanty evidence available (see Dawson, 1958) indicates that BMR of birds existing under natural conditions is not influenced by seasons, although it can undergo considerable modification in response to experimental conditions involving prolonged exposure to constant low or high temperatures (Gelineo, 1955). These observations illustrate the dichotomy, discussed by Hart (1957) and Fry (1958), between the natural process of seasonal acclimatization and laboratory-induced acclimation.

Lower critical temperature and energy requirements in the cold.—The fact that the Evening Grosbeak actually encounters severe winter conditions in nature renders its physiological responses to temperature of considerable comparative interest. The lower critical temperature of this bird, 16°C., is at least 6°C. lower than those reported for most other passerines weighing less than 75 gm. (see Dawson, 1958, table 1), excepting the Cardinal (*Richmondena cardinalis*), the Snow Bunting (*Plectrophenax nivalis*), and the Gray Jay (*Perisoreus canadensis*), for which the lower critical temperatures are 18°C., 10°C., and between 0°C. to −10°C., respectively. The relatively high critical temperatures of the grosbeak and other small birds which encounter low temperatures

in nature provide support for the view that small and medium-sized passerines existing in cold climates must sustain elevated rates of heat production for long periods of time. Even the Gray Jay with its relatively low critical temperature must augment its heat production during winter if body temperature is to be maintained at normal levels, for it frequently encounters temperatures below −10°C. at this season in the northern regions which it inhabits.

The fact that the Evening Grosbeak must resort to increased heat production for maintenance of body temperature in cold environments prompts estimation of the metabolic rate required under various thermal conditions. This can easily be accomplished graphically or with knowledge of the critical thermal gradient (the difference between body temperature and the lower critical temperature), which is 25°C. for this species. Doubling of the basal rate of heat production would, if overall insulation remained at the level existing at the lower critical temperature, permit maintenance of body temperature at 41°C. in an environment at −9°C.; the 50° difference between these temperatures representing twice the critical thermal gradient. Trebling the basal rate of heat production would allow the animal to remain at 41°C. in an environment at −34°C.; the 75° difference between these temperatures representing three times the critical thermal gradient. Obviously, under natural conditions, rate of air movement, factors affecting radiational losses, and others, would make modification of the above estimates necessary. However, they are useful for indicating in a general way the extent of the energetic problems posed to the Evening Grosbeaks by cold.

The apparent necessity of this species for augmenting its heat production during winter raises an important question for future investigation. This concerns the nature of the mechanisms responsible for maintaining thermogenesis at elevated levels for prolonged periods. Recent work by Sellers, Scott, and Thomas (1954); Hart, Heroux, and Depocas (1956); and Heroux, Hart, and Depocas (1956), for example, has shown that there is a reduction of shivering accompanied by increased heat production in rats during chronic exposure to cold. This indicates that mechanisms for chemical regulation of metabolism, rather than increased muscular activity, are primarily responsible for maintenance of elevated heat production in these animals when cold-acclimated. Relatively little is known of this subject in birds. Steen and Enger (1957) found that short-term adjustment of heat production to cold in pigeons depended upon shivering. Unpublished observations by Hart mentioned in his review paper (1958) suggest that shivering is the primary mechanism for heat production in winter acclimatized birds. When paralyzed by curare, such animals cannot augment their heat production in response to either the calorigenic hormone noradrenaline or cold.

Estimation of thermal conductivity.—A number of authors, notably Scholander *et al.* (1950*b*), have discussed the principles governing heat exchange of homeothermic animals in relation to environmental temperature. In the generalizations which have been developed, the homeotherm is regarded as a heat machine with a certain minimal heat production which pertains in the range of environmental temperature known as the zone of thermal neutrality. Within this zone heat loss can be maintained at the same level as the minimal heat production by adjustment of overall insulation, that is, through vasomotor activity and through adjustment of the plumage or pelage. This overall insulation is considered to reach a maximum at the lower limit of the zone of thermal neutrality, the lower critical temperature. At environmental temperatures lower than this, thermal balance is maintained by increasing heat production.

By use of a simple physical model and by careful analysis of data on insulation and on the relationship between metabolism and environmental temperature in a number of homeotherms, Scholander and his associates (1950*a*) have shown that the difference be-

tween central body temperature and the lower critical temperature, the critical gradient $T\Delta_c$, is proportional to the basal rate of heat production and to the maximum value for overall insulation. Likewise they have also shown that the heat production below thermal neutrality is proportional to the temperature difference between body and environment, in accordance with Newton's Law of Cooling. It is assumed that the slope of the curve relating metabolism and temperature below thermal neutrality is related to the maximal overall insulation—the greater the insulation the more shallow the slope.

The observed relation between metabolism and temperature for the Evening Grosbeak conforms quite well to the generalizations previously outlined. We do not regard the gradual transition from regulation of body temperature through control of heat loss to regulation by adjustment of heat production as a serious deviation. Heat production below thermal neutrality is proportional to the temperature difference between body and environment, as indicated by the linear relation between oxygen consumption and environmental temperature below thermal neutrality, and by the fact that the regression line fitted to the data between −13°C. and +10°C. extrapolates to zero rate of metabolism at a temperature falling within the normal range of body temperature for this species. This implies that the insulation of the grosbeaks does not change below thermal neutrality (see "Results") and that a single constant, that for the slope of the regression line, can be used as a basis for calculation of heat loss incurred with overall insulation at a maximum, per unit of body surface (we have employed the formula $m^2=0.1\ Kg^{2/3}$ for estimating the surface area), per degree of temperature difference between the core of the body and the environment, per unit of time. We shall refer to the heat loss expressed in these terms as the thermal conductivity of the Evening Grosbeak, in line with the usage of Morrison and Tietz (1957). It amounts to 1.8 kcal. $m^{-2}\ °C.^{-1}hr.^{-1}$ in this bird. This value is only about two-thirds those reported by Morrison and Ryser (1953), for the thermal conductivity of two Wisconsin mammals of comparable size, a vole (*Microtus*), and a weasel (*Mustela*).

Behavior and ecology.—In view of the heightened energy requirements of the Evening Grosbeak in the cold, it is important to review those aspects of its behavior and ecology which facilitate procurement and storage of food during the short days of the northern winter, or those which tend to reduce the impact of the winter environment. It will also be appropriate in this review to consider pertinent information on other members of the subfamily Carduelinae.

The social foraging habits and strong flight of carduelines facilitate discovery of food afforded by fruiting conifers and other trees, which often occur in widely scattered groups. These birds feed in well-integrated flocks, which habit tends to miminize dispersal of individuals away from good food sources. Feeding birds regularly will call to passing flocks comprised of individuals of the same species, which thus gain an opportunity to share in the food. The nomadic wanderings in winter of many carduelines, including the Evening Grosbeak, regularly involve distances of hundreds of miles, and apparently represent an effective means of enhancing discovery and exploitation of food.

The Evening Grosbeak and other carduelines are capable of storing relatively large amounts of food in the crop, which is well developed in them and small or absent in birds of related groups. Such storage capacity must be of considerable importance in allowing the birds to maintain an elevated metabolic rate overnight in the cold. The storage capacity of the crop is augmented in the breeding season in certain species by the development of buccal pouches, which have been reported in *Leucosticte tephrocotis* (Miller, 1941), *L. atrata,* and *Pinicola enucleator* (French, 1954).

We attempted to measure the crop capacity of Evening Grosbeaks by sacrificing captive birds at dusk and weighing crop contents. Two birds examined on May 14 without

any preliminary period of fasting had nearly empty crops and were very fat (75.5 and 76.8 grams). We then starved a male, but provided it with water, for eight days, in order to induce it to fill its crop with sunflower seeds. After a feeding period of an hour, its crop contained 12 sunflower seeds weighing 1.85 grams which occupied a volume equivalent to approximately ⅘ the total capacity of this structure. Sunflower seeds consist of 28 per cent fat, 19 per cent protein, and, presumably, about 44 per cent carbohydrate, judging from figures given in "The Handbook of Biological Data." The total combustion of these materials in 2.3 gm. of sunflower seeds, which should approximate the crop capacity of the individual referred to above, could be expected to yield about 12.7 kcal. If the net energy of this amount of sunflower seeds is assumed to be 50 per cent of the combustion value, as seems reasonable from various studies of nutrition (Brody, 1945), this would provide the bird with approximately 6.4 kcal. At an environmental temperature of −9°C., the heat production of a fasting grosbeak would amount to approximately 1.3 kcal./hr. At this rate the 6.4 kcal. would be expended in slightly less than 5 hours. The remaining energy to carry the bird through the night would have to come from food in other portions of the digestive tract at nightfall and from body reserves of carbohydrate, fat, and perhaps protein. The crop capacity of the Evening Grosbeak may be greatly exceeded by that of certain other carduelines; a Pine Grosbeak weighing 81 gm. was observed to have nearly 6 gm. of staminate catkins from jack pine (*Pinus banksiana*) in its crop (Butsch, 1957).

Many small birds wintering in the north appear to evade winter conditions at the extreme by roosting in sheltered places. The use of holes in trees by chickadees (*Parus*) and nuthatches (*Sitta*) is an example. Little is known of the roosting habits of carduelines, but roosting sites are probably in thick vegetation. Mrs. Doris H. Speirs tells us that she has seen Evening Grosbeaks leaving a dense clump of conifers very early in the morning. Judging by the behavior of captive birds, crossbills (*Loxia*) may roost in thick terminal clusters of pine needles (Tordoff, 1954:350). The amount of protection afforded by these roosting places has not been measured, but it must be considerable.

Several features of the breeding biology of carduelines seem favorable to existence in cold climates. There is nearly continuous incubation of eggs and brooding of newly hatched young by the female, which is fed at the nest by the male. This high level of attentiveness must facilitate the maintenance of warm nest temperatures despite near-freezing air temperatures noted in the redpoll (*Acanthis*), for one, by Irving and Krog (1956). The capacity of the young to thrive on vegetable matter provided them through regurgitation by the parent is also of interest here, for it makes the breeding of members of this group largely independent of a supply of insects, which may be scarce or lacking in cold weather. In at least some species of carduelines, breeding seems primarily keyed to the availability of seed crops, irrespective of the time of year. Crossbills appear to provide the best example of this. The breeding of these birds seems wholly independent of day length, taking place when adequate concentrations of food, usually pine seeds, are found. Nesting of this species has been reported for every month of the year in such widely separated places as Maine and Colorado. In Colorado, the peak of nesting is often in midwinter. The success of this species in solving its energy problems in cold weather is eloquently demonstrated by its ability to reproduce successfully during the shortest days of the year, at temperatures ranging from 7°C. to −23°C., with up to several feet of snow on the ground (Bailey, Niedrach, and Baily, 1953:24, 33).

Carduelines offer intriguing opportunities for studies of cold adaptation, for they possess many attributes which seem to make them, as a group, better adjusted to cold than related passerines.

SUMMARY

This study of the effects of temperature upon oxygen consumption and body and skin temperatures of the Evening Grosbeak was undertaken in an effort to learn how small birds cope with extreme cold in nature. The basal metabolic rate for this bird, 2.5 cc. O_2/gm./hr., is similar to those of other passerines of comparable size (50–65 gm.). The grosbeak can through adjustment of its overall insulation maintain heat loss equal to its minimal heat production at environmental temperatures down to 16°C. which has been designated its lower critical temperature. Below 16°C. heat loss increases and normal body temperature can only be maintained by elevation of heat production from the minimal level at the rate of 1.8 kcal. per m^2 of body surface per degree lowering of environmental temperature per hour. This rate is only about two-thirds those noted for mammals of similar size, which indicates that the grosbeak surpasses them in the effectiveness of its overall insulation. Cooling of peripheral tissues does not appear to contribute significantly to this insulation, for skin temperature of this bird was maintained within 3°C. to 6°C. of body temperature even at subfreezing environmental temperatures.

The fact that the lower critical temperature of the Evening Grosbeak is well above the temperatures it regularly encounters in nature during winter means that it must in its temperature regulation resort to augmentation of its heat production at this season. This requires increased food intake when food is likely to be in shortest supply and the daylight hours for feeding most limited. A number of aspects of the behavior and ecology of the Evening Grosbeak, and of other carduelines as well, seem well suited for allowing them to contend with this situation. The social foraging habits and strong flight of these birds must facilitate location and exploitation of food. Their well developed crops must enable them to store prior to nightfall relatively large quantities of food. They may evade the full impact of their environment at night by utilizing various types of shelter. The capacity of young carduelines to thrive on vegetable matter makes them largely independent of a supply of insects, which might be scarce or lacking in the cold weather in which some species, notably crossbills, have been observed to breed.

LITERATURE CITED

Bailey, A.M., Niedrach, R. J., and Baily, A. L.
1953. The red crossbills of Colorado. Denver Mus. Nat. Hist., Mus. Pictorial No. 9, 64 pp.

Brody, S.
1945. Bioenergetics and growth (Reinhold Publ. Corp., N.Y.).

Butsch, R. S.
1957. Notes on the winter birds of Sugar Island, Michigan. Jack-Pine Warbler, 35:14–19.

Dawson, W. R.
1958. Relation of oxygen consumption and evaporative water loss to temperature in the cardinal. Physiol. Zool., 31:37–48.

Depocas, F., and Hart, J. S.
1957. Use of the Pauling oxygen analyzer for measurement of oxygen consumption of animals in open-circuit systems and in a short-lag, closed-circuit apparatus. Jour. Appl. Physiol., 10:388–392.

French, N. R.
1954. Notes on breeding activities and on gular sacs in the pine grosbeak. Condor, 56:83–85.

Fry, F. E. J.
1958. Temperature compensation. Ann. Rev. Physiol., 20:207–224.

Gelineo, S.
1955. Température d'adaptation et production de chaleur chez les oiseaux de petite taille. Arch. Sci. Physiol., 9:225–243.

Hart, J. S.
1957. Climatic and temperature induced changes in the energetics of homeotherms. Rev. Can Biol., 16:133–174.
1958. Metabolic alterations during chronic exposure to cold. Fed. Proc., 17:1045–1054.
Hart, J. S., Heroux, O., and Depocas, F.
1956. Cold acclimation and the electromyogram of unanesthetized rats. Jour. Appl. Physiol., 9:404–408.
Heroux, O., Hart, J. S., and Depocas, F.
1956. Metabolism and muscle activity of anesthetized warm and cold acclimated rats on exposure to cold. Jour. Appl. Physiol., 9:399–403.
Irving, L., Krog, H., and Monson, M.
1955. The metabolism of some Alaskan animals in winter and summer. Physiol. Zool., 28:173–185.
Irving, L., and Krog, J.
1956. Temperature during the development of birds in arctic nests. Physiol. Zool., 29:195–205.
King, J. R.
1957. Comments on the theory of indirect calorimetry as applied to birds. N.W. Sci., 31:155–169.
Miller, A. H.
1941. The buccal food-carrying pouches of the rosy finch. Condor, 43:72–73.
Morrison, P. R., and Ryser, F. A.
1953. Temperature and metabolism in some Wisconsin mammals. Fed. Proc., 12:100–101.
Morrison, P. R., and Tietz, W. J.
1957. Cooling and thermal conductivity in three small Alaskan mammals. Jour. Mamm., 38:78–86.
Peters, J. P., and Van Slyke, D. D.
1946. Quantitative clinical chemistry. 2nd ed. (William and Wilkins Co., Baltimore).
Scholander, P. F.
1955. Evolution of climatic adaptation in homeotherms. Evolution, 9:15–26.
Scholander, P. F., Hock, R., Walters, V., and Irving, L.
1950*a*. Adaptation to cold in arctic and tropical mammals and birds in relation to body temperature, insulation, and basal metabolic rate. Biol. Bull., 99:259–271.
Scholander, P. F., Hock, R., Walters, V., Johnson, F., and Irving, L.
1950*b*. Heat regulation in some arctic and tropical mammals and birds. Biol. Bull., 99:237–258.
Sellers, E. A., Scott, J. W., and Thomas, N.
1954. Electrical activity of skeletal muscle of normal and acclimatized rats on exposure to cold. Amer. Jour. Physiol., 177:372–376.
Spector, W. S. (ed.)
1956. Handbook of biological data (W. B. Saunders Co., Phila.).
Steen, J., and Enger, P. S.
1957. Muscular heat production in pigeons during exposure to cold. Amer. Jour. Physiol., 191:157–158.
Tordoff, H. B.
1954. Social organization and behavior in a flock of captive, nonbreeding red crossbills. Condor, 56:346–358.

Department of Zoology and Museum of Zoology, The University of Michigan, Ann Arbor, Michigan, April 17, 1959.

ECOLOGICAL AND DISTRIBUTIONAL RELATIONS OF DESERT SCRUB BIRDS OF WESTERN TEXAS

By KEITH L. DIXON

In the deserts of North America, as in other areas remote from centers of population, initial studies of the avifauna were directed principally along taxonomic and distributional lines. In recent years, interest in desert birds has broadened, and studies of breeding bird populations, life histories of individual species, and physiological ecology have been undertaken. The principal focus of the investigations reported here was determination of habitat preferences and population density of birds breeding in desert scrub vegetation in southern Brewster County, Texas, as a part of a long term study of community relations of vertebrates of the Big Bend area. Field work involved parts of four nesting seasons, 1955 to 1958 inclusive. Studies were conducted in the Big Bend National Park and on the Texas Game and Fish Commission's Black Gap Wildlife Management Area, lying east of Big Bend Park and 53 miles southeast of Marathon, since these areas were relatively undisturbed insofar as present economic exploitation is concerned. Taxonomic and distributional background is provided by the writings of Van Tyne and Sutton (1937) and Miller (1955).

ACKNOWLEDGMENTS

These studies were supported by the Texas Game and Fish Commission under contract with the Texas Agricultural Experiment Station, with the cooperation of the National Park Service. Grateful appreciation is expressed to E. A. Walker and T. D. Moore of the Game Commission, and George W. Miller, Harold J. Broderick and their associates of the National Park Service for assistance in many ways, and to W. B. Davis, O. C. Wallmo and John Davis for suggestions concerning the manuscript.

METHODS

The method used was the censusing of singing males as developed by Williams (1936), special reliance being placed upon records of simultaneous singing by two or more individuals. Repeated visits to the study areas were made in the early morning or evening hours, and the positions of individual birds were recorded on maps. Records were transferred later to composite maps for each species. These maps, supplemented by field notes, were used to estimate the number of territories for each species. Kendeigh's (1944:91) recommendation that a minimum of five censuses be spaced through the nesting season was followed insofar as possible.

Some workers, among them Breckenridge (1955), have questioned the validity of results obtained by this method, although Stewart *et al.* (1952:269) estimated the accuracy at "over 90 per cent" in deciduous forest and adjacent habitats in Maryland. Earlier, Hickey (1943:83) had demonstrated some variability in the percentage of known residents of a plot that would be detected on a single trip through the area. Among seven species of warblers the value approximated three-fourths of the individuals. The difficulties involved in enumerating the birds decrease in the open growth in which our censuses were taken, although confusion resulting from intruding individuals sometimes was difficult to resolve.

To circumvent the difficulties of estimating fractions of territories of thinly distributed species in the process of reaching a density figure for a given plot, the number of males judged to include some part of the area in their activity ranges was indicated in parentheses following the "density" value, in addition to the latter figure. Thus, in table 1

we may see that in 1956 two Pyrrhuloxia males were active on the area, although the streambed traversing the 33 acres did not appear to include all of the area occupied and defended by either male. For some species these figures for actual numbers recorded may reflect more accurately the relative abundance of a given species in the area represented by the plot (for year-to-year comparisons) than do territorial equivalence values (sum of territories and fractions thereof) conventionally reported in breeding bird censuses.

Probably greater value will accrue from records of the presence or absence of species on the study plots in subsequent years rather than from interpreted changes in absolute density for a particular species. Data to support the latter type of interpretation are hardly justified on plots of the size censused. On the other hand, larger plots could not have been covered in their entirety before avian activity diminished with increasing warmth of the day.

CENSUS PLOTS

Black Gap area.—In 1956, a 33-acre plot was established at 2200 feet elevation, 2½ miles by road east of the Headquarters, at the top of the hill west of the Dell Tank. The area is one of low limestone hills bisected by a dry streamcourse. The vegetation on dry detrital slopes consists of an open stand of shrubs two to six feet in height (*Larrea*

Table 1

Breeding-bird Populations on a 33-acre Plot, Open Desert Scrub Bisected by a Dry Streamcourse, 2.5 Miles by Road East of Black Gap Headquarters, 2200 Feet, Brewster County, Texas

Species	1956		1957		1958	
	Equiv. terr.[1]	Males active on plot[2]	Equiv. terr.	Males active on plot	Equiv. terr.	Males active on plot
Scaled Quail	V (3 days)		V (7 days)		V (3 days)	
Mourning Dove	2	(3)	1	(1)	3.5	(4)
Elf Owl					V (1 night)	
Trilling Nighthawk	2.5	(3)	1	(2?)	1.5	(2)
Poor-will	V (1 day)		V (2 days)		+	(1)
Ladder-backed Woodpecker			V (2 days)		V (6 days)	
Ash-throated Flycatcher	1+	(2?)	+	(1)	0.5	(1)
Verdin	+	(1)	1	(1)	1	(1)
Cactus Wren	1	(2)	1	(1)	1	(1)
Mockingbird	2+	(4)	1+	(4)	1+	(2)
Curve-billed Thrasher			V (1 day)			
Black-tailed Gnatcatcher	2+	(3)	1	(1)	1	(2)
Scott Oriole	1	(2)	0.5	(1)	+	(1)
Brown-headed Cowbird	V (1 day)				V (1 day)	
Pyrrhuloxia	1.5	(2)	1	(1)	1	(1)
House Finch	2	(3?)	1+	(2)	2	(2)
Black-throated Sparrow	2	(3)	1.5	(3)	1+	(3)
Totals	17+	(29)	10+	(18)	13.5+	(20)
Territorial males per 100 acres	51+		30+		40+	

[1] Equivalent territories; + indicates less than 0.5 territories; V denotes a species apparently nesting nearby, but occurring on the plot irregularly.

[2] Number of males whose territories extended onto the plot; see text.

Coverage: 1956, March 20, 22; April 26, 29; May 3, 19, 20; June 13, 23; total man-hours, about 17.
1957, March 20, 22; April 21, 22, 23, 24; May 10, 11, 12, 14, 15; total man-hours, about 17.
1958, March 24, 27, 28, 29, 30; April 1, 24, 25, 26, 27; May 24, 25, 26, 27, 28; total man-hours, about 17.

tridentata, Acacia constricta, Porlieria angustifolia) grading into a denser scrub growth with a ground layer of the leaf succulent *Agave lechuguilla*. In its densest faciation on limestone rock slopes, this growth includes *Agave* and another leaf succulent (*Hechtia* sp.), a low semi-succulent—the sotol (*Dasylirion leiophyllum*), and shrubs such as *Leucophyllum* sp., *Acacia* spp., and *Forestiera angustifolia*. The streambed supports a more or less continuous growth of rather thin-foliaged shrubs, three to nine feet in height, of which *Acacia constricta, Larrea, Forestiera, Condalia* and *Lippia ligustrina* are prominent (fig. 1). Scattered along this ribbon of shrubbery and extending interruptedly along lateral drainageways are clumps or isolated individuals of the broad-bladed *Yucca torreyi*. Strands of a taller but shorter-leaved yucca (*Y. rostrata*) occur on one of the north-facing slopes (fig. 1). These small stands of either species of yucca may be considered as special habitat features rather than as distinct habitats.

Although the selection of a study plot lacking uniformity of vegetation may seem out of step with current practices in censusing of breeding birds (Pough, 1947), it did serve to emphasize certain points concerning habitat requirements of some breeding species. The activities of at least five species (Mockingbird, Pyrrhuloxia, Verdin, Cactus Wren, Black-tailed Gnatcatcher) were centered in the denser growth of the creekbed, and these would not have been expected in more open areas. Three others (Ash-throated Flycatcher, Scott Oriole, and House Finch) apparently depended upon one of the yucca species for nest sites and/or song perches. (Scientific names of most of the species mentioned in text appear in table 3.) The feathery-leaved shrubs of the creekbed evidently did not provide sufficient shelter and/or foraging sites for several species of thicket-dwelling birds that occurred sparingly elsewhere on the Black Gap area: Bewick Wren, Crissal Thrasher, Phainopepla, Bell Vireo, and Varied Bunting.

The results of three censuses for 1956 to 1958 are presented in table 1. It may be seen that the same 11 species were present and presumably nesting in each of the three years; the twelfth species, the Poor-will was active on the plot in 1958 only. A real decrease in population density from 1956 to 1957 was evident, and it is corroborated by the decreased numbers of males of several species.

The nesting birds of desert scrub vegetation of the Black Gap area as reported by Thompson (1953) are listed in table 3. In addition, I heard the Elf Owl (*Micrathene whitneyi*) at two localities in 1958, and took a male Cassin Sparrow (*Aimophila cassinii*) in a thicket of mesquite (*Prosopis*) and catclaw (*Acacia greggii*) on the bank of Maravillas Creek in June, 1956. The Brown Towhee is found locally on the Black Gap area on lava rock slopes of somewhat denser vegetation, including sotol, and its occurrence in desert scrub vegetation in western Texas is local and marginal, as indicated by Davis (1951:48–49). One male Lark Sparrow, taken in a stand of mesquite in June, 1956, was the only individual of this species seen on the Black Gap area during this investigation.

Big Bend National Park.—A census plot referred to hereafter as the Burnham Flat plot was established in 1957 on the gradually sloping outwash plain north of the Chisos Mountains. This plot, situated at 3400 feet elevation, 3.1 miles by road north of Government Spring, was enlarged from 20 to 33 acres in 1958. The alluvial slope is dissected by shallow drainageways along the eastern and western margins of the 33-acre plot, and by a central creekbed as well. None of these narrow arroyos supports a continuous growth of denser vegetation, although the composition, including scattered individuals of *Yucca torreyi*, is more varied than that of the surrounding slopes. The largest arroyo, along the western margin, is dotted with shrubs of denser foliage, including *Forestiera* and *Diospyros texana*. A prominent feature of the entire plot is the rather dense ground cover of *Agave lechuguilla* (fig. 2). The shrubs (*Larrea, Porlieria, Flourensia cernua, Koeberlinia spinosa, Condalia obtusifolia, Prosopis*) are more scattered and of lower

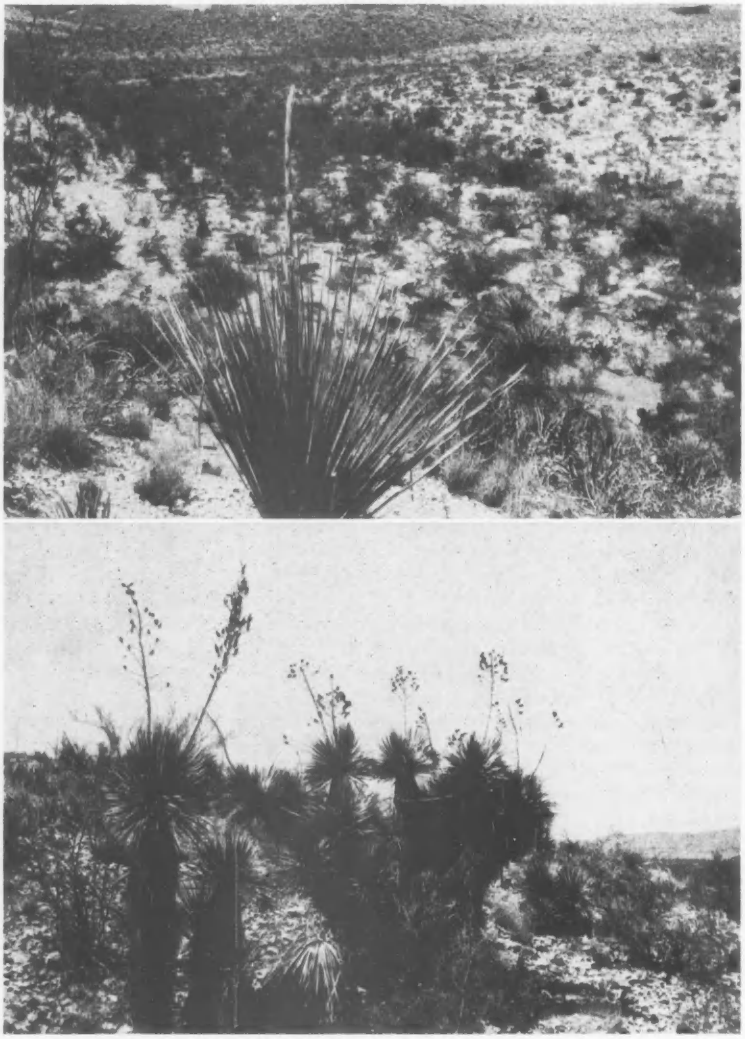


Fig. 1. Upper: view of desert scrub bisected by dry streamcourse on Black Gap census plot, *Dasylirion leiophyllum* in center foreground.
Lower: stand of *Yucca rostrata* on limestone slope.

stature than those on the Black Gap plot. As on the latter area the herbaceous layer consists principally of the perennial bunch grass (*Bouteloua breviseta*), with scattered ephemerals. Bare pebbly or stony ground predominates.

The census data for the two years are presented in table 2. One may note a more

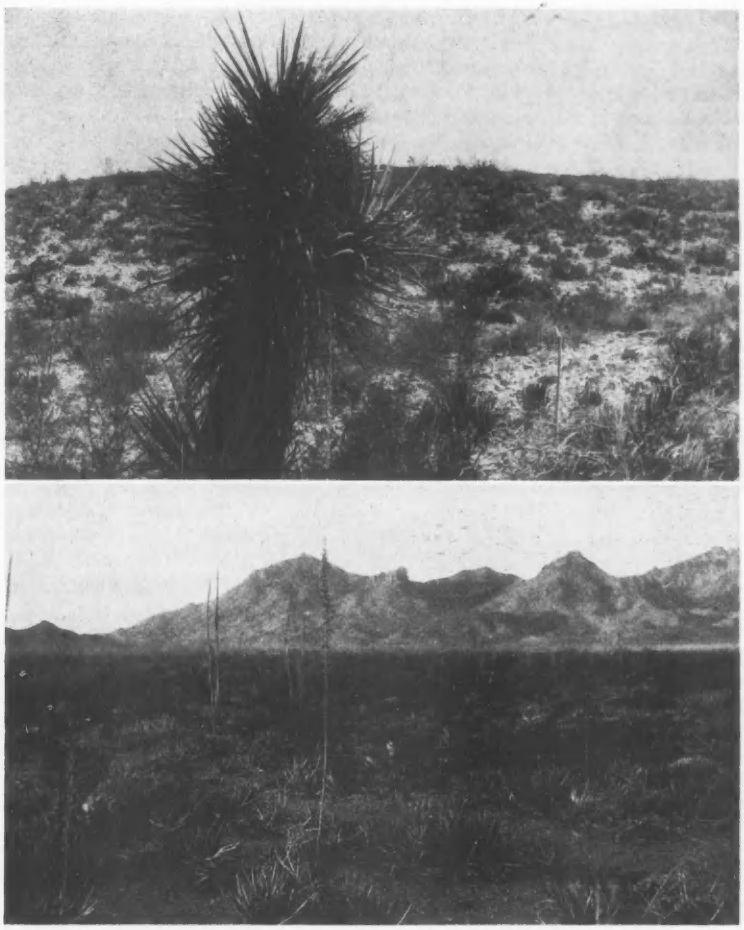


Fig. 2. Upper: desert scrub of Black Gap census plot; *Yucca torreyi* in foreground. Lower: view of Burnham Flat plot showing *Agave lechuguilla* in flower and Chisos Mountains in background.

depauperate fauna and greater variability in composition than that obtaining on the Black Gap census plot. This condition derives from the fact that the vegetation was sparser and less diverse, although it was representative of extensive portions of the outwash plain. Denser stands of shrubs occurred nearby along slightly larger arroyos, and the presence on the plots of Mockingbirds, Pyrrhuloxias, and Cactus Wrens apparently depended upon the population densities of those species in the more desirable stands. This assumption is based on the findings of Kluyver and Tinbergen (1953) in which they reported that certain forest birds in The Netherlands "spilled over" into less desir-

able habitats only in years of higher population density. In addition to those species that appeared on the plot as visitors, the Mourning Dove, Poor-will, Ladder-backed Woodpecker and Brown Towhee occurred sparingly on Burnham Flat. In a rather extensive thicket of taller mesquites with a dense undergrowth of thorny shrubs, such as *Condalia* and *Acacia greggii*, the following additional species were heard: White-winged Dove (1957 only), Elf Owl (1958 only), Verdin, and Bell Vireo.

The presence of surface water within one mile of the Black Gap plot may have accounted for the nesting there of some species, such as the Mourning Dove and House Finch, although possibly the presence of more song perches (for which purpose dead sotol plants were used by Mourning Doves), and the shade provided by denser-foliaged shrubs may also have exerted an influence. Additionally, food patches of Johnson grass (*Sorghastrum*) scattered over the Black Gap area may have favored the granivorous species. The more varied vegetation of the Black Gap plot appears to have attracted more species and more individuals even if those species restricted to the creekbed (Verdin, Pyrrhuloxia) are excluded.

Table 2

Breeding-bird Populations of Open Desert Scrub, 3.1 Miles North of Government Spring, 3400 Feet, Brewster County, Texas

Species	1957 20 acres Equivalent territories[2, 3]	1958[1] 20 acres Equivalent territories	1958[1] 33 acres Equivalent territories
Scaled Quail		+ (1)	+ (1)
California Roadrunner			V (1 day)
Trilling Nighthawk	+ (1)	+ (1)	+ (1)
Poor-will			V (1 night)
Ash-throated Flycatcher	V (1 day)		V (2 days)
Cactus Wren			V (3 days)
Mockingbird	V (2 days)	+ (1)	+ (2)
Black-tailed Gnatcatcher	+ (1)	1 (1)	1 (1)
Loggerhead Shrike			V (1 day)
Scott Oriole	V (2 days)		V (1 day)
Brown-headed Cowbird	*		V (3 days)
Pyrrhuloxia	1 (2)		V (2 days)
House Finch	V (3 days)		V (2 days)
Black-throated Sparrow	2+ (4)	1+ (2)	2 (3)
Totals	3+ (7)	2+ (6)	3+ (8)
Territorial males per 100 acres	15+	10+	(10+)

[1] Plot enlarged from 20 to 33 acres in 1958; values for original plot are presented for comparison to data for 1957.
[2] + indicates less than 0.5 territories; * denotes presence, territory size difficult to assess; V denotes a species apparently nesting nearby, but occurring on the plot only irregularly.
[3] Values in parentheses indicate number of males whose territories extended onto the plot.
Coverage: 1957, April 18, 19, 20, 21; May 12, 24, 28; total man-hours, 13½.
1958, March 23; April 2; May 1, 2, 21, 22, 24; total man-hours, 12.

COMPARISONS TO OTHER AREAS

Both the census plots are fairly representative of the upland desert scrub vegetation of the Big Bend area. Floristically and structurally both may be considered as characteristic of the Chihuahuan Desert as described by Shreve (1942; 1951), and Le Sueur (1945). Shreve (1951:23) characterized the vegetation as ". . . essentially one in which dominance is shared by microphyllous shrubs and low stem succulents or tall semisucculents." The absence of trees is noticeable. The vegetation of the census plot on the Black Gap area fits almost exactly Shreve's (1942:240) description of the ". . . most

distinctive type of vegetation in northern Coahuila," and Le Sueur (1945:56) mentions the occurrence of this complex in eastern Chihuahua. However, the presence of a number of woody plant species listed by Muller (1947) as characteristic of the Tamaulipan thorn shrub of the Gulf coastal plain of northeastern México and southern Texas indicated a transition to that formation. Prominent among the species not listed from eastern Chihuahua by Le Sueur are the shrubs *Porlieria angustifolia, Diospyros texana* and *Lippia ligustrina*. The absence of *Flourensia cernua* from the Black Gap plot is further evidence of this replacement.

The assemblages of birds listed for the Black Gap area and for the Burnham Flat–Grapevine Springs area north of the Chisos Mountains (table 3) compare favorably with those listed for desert scrub at somewhat higher elevations at the base of the Guadalupe Mountains in northern trans-Pecos Texas (Burleigh and Lowery, 1940), and at the eastern base of the nearby Sierra del Carmen of Coahuila (Miller, 1955). With the exceptions listed beyond, no other species of the upland desert scrub was found by Phillips and Thornton (1949:109) for the area between the Sierra Vieja and the Rio Grande in western Presidio County, Texas. This assemblage, then, may be considered a characteristic one for the eastern portion of the Chihuahuan Desert, and I know of no additional species listed in Part 2 of the Mexican Check-list (Pacific Coast Avifauna No. 33, 1957) as occupying Mexican portions of this desert. Excluded from this list are species which range widely and, although foraging in desert scrub, are not attracted to this formation *per se*. Among these are the vultures, diurnal raptors, the Horned Owl (*Bubo virginianus*) and ravens (*Corvus corax* and *C. cryptoleucus*). Excluded also are species, such as the Say Phoebe (*Sayornis saya*) and Rock (*Salpinctes*) and Canyon (*Catherpes*) wrens, which require special features of the geological substrate for nesting, and the oasis inhabitants, such as the Black Phoebe (*Sayornis nigricans*) and Vermilion Flycatcher (*Pyrocephalus rubinus*).

A comparison of the avifauna of the Chihuahuan Desert scrub as here defined to those of the other "creosote bush" deserts (Sonoran and Mojave, as delimited by Shreve, 1942) reveals that the majority of the species are ones that range widely over the deserts of southwestern North America. There are 13 species marked with an asterisk in table 3 that might be considered to comprise a "standard" desert avifauna, occurring in all three of the warm deserts (including the Baja California section of the Sonoran desert, according to Bancroft, 1930). Five of these were detected in Great Basin sagebrush (cold desert) by Fautin (1946), and Behle (1955:10) reported seven from similar habitat. Eight species of more or less regular occurrence in the Chihuahuan Desert also are found in Californian chaparral (four of them represented by populations that are racially distinct from those of the deserts, according to Grinnell and Miller, 1944). Sixteen species of the Chihuahuan Desert are listed from Tamaulipan thorn shrub in Bexar County, Texas, by Quillin and Holleman (1918). Since their writing the House Finch has extended its range into that county. Populations of six of the 16 species differ racially from those of the desert to the west. (For a discussion of the structure of this brushland in relation to the occurrence of certain bird species, see Chapman, 1891:315). To a considerable extent this occurrence of desert species in adjacent formations indicates an attraction to the shrub life form and not to the desert climate *per se*, and in this respect it supports the arguments of Udvardy (1958:62) relative to the derivation of the desert avifauna from that of arboreal formations.

In his discussion of the North American deserts Shreve (1951:25) stated that ". . . the Sonoran Desert is by far the richest in number of life forms and in variety and development of communities . . . and . . . the wealth of life forms . . . is reduced in number and in physiognomic importance on passing north or east into other deserts. Lower rain-

Table 3

Distribution of Birds of Regular Occurrence in Scrub Vegetation of the Chihuahuan Desert

Locality and authority for each of the columns are listed below; asterisk indicates "standard" desert scrub avifauna; values in column 7 are males per 100 acres; V denotes visitor, r indicates infrequent occurrence.

Species	Great Basin	Chap-arral	Mojave Desert		Sonoran Desert						Chihuahuan Desert				Tamaulipan thorn shrub
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Scaled Quail (*Callipepla squamata*)											x	x	x	x	x
*Mourning Dove (*Zenaidura macroura*)	x		x	(x)	x		V	x	x	x	x	x	x	x	x
White-winged Dove (*Zenaida asiatica*)							7	x	x	x		x	x	r	
*California Roadrunner (*Geococcyx californianus*)		x	x	x	x	x		x	x	x	x	x	x	x	x
Elf Owl (*Micrathene whitneyi*)						x		x	x				r		
*Trilling Nighthawk (*Chordeiles acutipennis*)			x	x	x	x		x	x	x	x	x	x		
*Poor-will (*Phalaenoptilus nuttallii*)		x	x	x	x	x		x	x	x	x	x	x	x	
Black-chinned Hummingbird (*Archilochus alexandri*)						x					r	x	r	x	
*Ladder-backed Woodpecker (*Dendrocopos scalaris*)			x	x	x	x	V	x	x	x	x	x	x	x	x
*Ash-throated Flycatcher (*Myiarchus cinerascens*)	V	x	x	(x)	x	x	1	x	x	x	x	x	x	x	x
*Verdin (*Auriparus flaviceps*)			x	x	x	x	5	x	x	x		x	x	x	x
Bewick Wren (*Thryomanes bewickii*)		x	x	x							x	x		x	x
*Cactus Wren (*Campylorhynchus brunneicapillus*)			x	x	x	x	8	x	x	x	x	x	x	x	x
*Mockingbird (*Mimus polyglottos*)			x	x			V	x		x	x	x	x	x	x
Curve-billed Thrasher (*Toxostoma curvirostre*)							2	x	x		x	x	x	x	x
Crissal Thrasher (*Toxostoma dorsale*)			x			x		x	x		x	x		x	
*Black-tailed Gnatcatcher (*Polioptila melanura*)		x		x	x	x	6	x	x	x		x	x		
Phainopepla (*Phainopepla nitens*)			x	x		x	1	x	x	x				x	
*Loggerhead Shrike (*Lanius ludovicianus*)	x		x	x	r	x		x	x	x	x	x	x	x	
Bell Vireo (*Vireo bellii*)					x				x			x	x		x
Scott Oriole (*Icterus parisorum*)			x	x					x		r	x	x	x	
Brown-headed Cowbird (*Molothrus ater*)			x	x				x	x		r	x	x		x
Pyrrhuloxia (*Pyrrhuloxia sinuata*)									x	r	x	x	x		x
Varied Bunting (*Passerina versicolor*)									r			r	x	x	
*House Finch (*Carpodacus mexicanus*)	V	x	x	(x)	x	x	2	x	x	x	x	x	x	x	(x)
Brown Towhee (*Pipilo fuscus*)		x		x	r			r	x		r	x	r	x	

Species	Great Basin	Chaparral	Mojave Desert		Sonoran Desert						Chihuahuan Desert				Tamaulipan thorn shrub
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lark Sparrow (*Chondestes grammacus*)		x		x				r			x			x	x
*Black-throated Sparrow (*Amphispiza bilineata*)	x		x	x	x	x	+	x	x	x	x	x	x	x	x
Other breeding species of desert scrub			9	8	3	5	11	10	14	7	1	0	0	2	
Total species			26	28	17	20	23	31	35	23	22	25	23	24	
Diurnal raptor species			4			3	3	4	6	6	3	1	2		

[1] Great Basin Desert, western Utah, Fautin, 1946.
[2] Californian chaparral, general, Miller, 1951:547–548.
[3] Providence Mountains area, Johnson, Bryant and Miller, 1948:241–243.
[4] Mojave Desert, general, Miller, 1951.
[5] Eastern base, San Jacinto Mountains, Grinnell and Swarth, 1913; Dixon, MS.
[6] Colorado River area, Grinnell, 1914.
[7] Organ Pipe Cactus National Monument, Arizona, Hensley, 1954:195 (see text).
[8] Organ Pipe Cactus National Monument, Arizona, Huey, 1942.
[9] Papago Indian Reservation, Arizona, Sutton and Phillips, 1942.
[10] Lower California, Lat. 27° N, Bancroft, 1930.
[11] Guadalupe Mountain area, Texas, Burleigh and Lowery, 1940.
[12] Black Gap Wildlife Area, southeastern Brewster County, Texas, Thompson, 1953.
[13] Burnham Flat-Grapevine Spring area, Chisos Mountains, Texas, Dixon, MS.
[14] Sierra del Carmen area, Coahuila, Miller, 1955.
[15] Brushland section, Bexar County, Texas, Quillin and Holleman, 1918.

fall, limitation of rain to a single season, and lower winter temperatures are the principal factors involved." Inspection of the totals for desert scrub bird species in the several columns in table 3 suggests that the influence of these contrasts in vegetation structure on avifaunal composition is a controlling one. In the "Arizona Upland" section of the Sonoran Desert (Shreve, 1951:60) the "standard" desert scrub avifauna is augmented by a number of species most of which are closely associated with the towering saguaro cactus (*Carnegia gigantea*). The relationship to structural diversity in one locality may be seen in Hensley's (1954:195) listing of censuses of breeding birds of four plots representing increasing complexity of vegetation in southern Arizona. No species was found nesting in a pure stand of creosote bush, whereas the highest densities and greatest representation of species occurred on plots traversed by "washes" lined by arborescent mesquites, palo verdes, and ironwood. The densities in pairs per 100 acres on Hensley's "open desert" plot (intermediate in structural diversity) are given in table 3 for comparison to the census values in tables 1 and 2. In population density and number of species, the sample is comparable to that for the Black Gap study plot. (The absence of the Trilling Nighthawk and the Poor-will from Hensley's plots is surprising in view of Huey's, 1942:366, comments on their abundance in that vicinity.)

The presence of more ecologic niches, or ways of life in the sense of Elton (1927:63), is evident in the more diverse avifauna of the Arizona Upland desert. Occurring in the same stands in that association there may be several species of the same family; examples are found among the doves, woodpeckers, and *Myiarchus* flycatchers, and in the presence of four species of *Toxostoma* in the same vicinity, as listed by Sutton and Phillips (1942:62). In contrast, one species per family is the rule in the birds of Chihuahuan Desert scrub as here delimited, with the exception of the finch assemblage and the doves. The two species of thrashers are sparsely distributed and segregated as to habitat. This avifauna is a depauperate one, not distinguished by any unique species or combinations of species (except for the greater prevalence of the Varied Bunting). The simpler composition seems clearly related to the structure of the vegetation.

The vegetation and avifauna of the Chihuahuan and Mojave deserts present certain parallels to one another, and, along with the western section of the Sonoran Desert (the

Colorado Desert of many authors), they stand in contrast to the Arizona Upland area. However, many of the populations are more or less continuously distributed throughout the western desert area, whereas there is a distinct vegetational break between the Sonoran and Chihuahuan deserts (Shreve, 1951:23). In addition to avifaunal composition, there is a contrast in the roles played by Screech (*Otus asio*) and Elf owls in the high elevation deserts. Miller and Miller (1951:161) stated that Screech Owls ". . . occur widely across the deserts of the southwestern United States and the northwestern states of México;" however, they (p. 174) commented upon the rarity of this species in many parts of the Mojave Desert, and in the Big Bend area of Texas the Screech Owl is restricted to the oak belt in the mountains, and the Elf Owl is virtually so. In the Chihuahuan Desert hummingbirds are more restricted in their habitat distribution, and it is my impression that there are fewer diurnal raptors present.

DERIVATION OF DESERT SCRUB AVIFAUNAS

The absence of physiological and morphological specializations for conditions of extreme aridity has been noted by Udvardy (1958:62), who attributed this lack of avian specialization to the relatively recent origin of the North American deserts. This conclusion was supported (1) by the interpretation of Axelrod (1950) that woody vegetation of the deserts was segregated out of more generalized floras with increasing aridity at the close of the Tertiary, and (p. 262) ". . . became adapted to regional desert climate in post-Middle Pliocene time," and (2) by the physiological investigations of Bartholomew and his associates. The colonization of this unfavorable environment appears to have been accomplished principally by behavioral adjustments (see Hensley, 1954:22 and Dawson, 1954:107–117) rather than physiological specializations (see Bartholomew and Cade, 1956:409–411, and Bartholomew and Dawson, 1958:154). Conceivably, however, factors other than time alone could have been operative in restricting the development of specializations for existence in desert scrub. The differentiation of the Abert Towhee (*Pipilo aberti*) from Brown Towhee stock, as reconstructed by Davis (1951:98–99), indicates that the Sonoran Desert must have been in existence for a period sufficient to permit the evolution of that species at least. Davis concluded that populations of Brown Towhees were crowded into riparian thickets of the lower Colorado River drainage by the encroachment of grassland, and that the differentiation of *P. aberti* took place along the streamcourses. Thus the isolation necessary for speciation was provided by discontinuities in vegetation. Perhaps the progenitors of the Lucy Warbler (*Vermivora luciae*) also were forced to enter riparian timber (inhabited in southwestern Utah today, according to Behle, 1943:15) or mesquite forest, where their evolution could have proceeded in isolation (see Grinnell, 1914:99).

We should be cautious in supposing that species now inhabiting a given region evolved there, for Miller (1943) reported the occurrence of the Gilded Flicker (*Colaptes chrysoides*), a species now found only west of the continental divide, from a Pleistocene deposit in Nuevo León in northeastern México. Nevertheless a number of species, such as the Elf Owl, Gila Woodpecker (*Centurus uropygialis*), several species of thrashers, and the Lucy Warbler, appear to have centers of distribution or abundance in the more varied sections of the Sonoran Desert. Regardless of their area of origin, these are essentially geographic (and ecologic) representatives of widespread groups that filled vacant niches that existed there but not in other desert regions, a view advanced by Swarth (1920:14). However, the desert scrub vegetation as a whole presents few opportunities for diverse ways of life, and apparently it came to be occupied by a few widely ranging species that possibly broadened their ecologic amplitude in the absence of competitors. The populations of most of these species probably were connected with others of their

species at least intermittently by continuity of desert scrub with woodland at higher elevations or with arid subtropical scrub to the south or east. Species ranging into the deserts from centers of abundance in woodland today include the Ladder-backed Woodpecker, Ash-throated Flycatcher and Scott Oriole. Examples of species that may have entered the deserts originally from arid subtropical scrub include some that exhibit definite altitudinal limits in the Chisos Mountains of Texas, such as the Trilling Nighthawk, Black-tailed Gnatcatcher, Verdin and Pyrrhuloxia. The geographic distribution of these species in the southwestern United States, and the occurrence of all but the gnatcatcher in "tropical" areas of Sonora (van Rossem, 1945) support this contention. Apart from the ground-dwelling quails and thrashers, few species are restricted to desert scrub vegetation (see table 3 and Miller, 1951:543–544), a fact that seems related to Axelrod's (1950:255) observation concerning woody plants that "large numbers of arid subtropical scrub species also make up an integral part of Sonoran and Chihuahuan desert vegetation." Thus, it would appear that the occupancy of desert scrub by a few euryoecious species (resulting in reduction of ecologic opportunity) and the incompleteness of their isolation from conspecific populations in other more or less arborescent formations have hampered evolution in new directions in birds occurring in the desert scrub of the southwestern United States.

SUMMARY

Breeding-bird population data from two plots in desert scrub in the Big Bend area of Texas, censused for 2 and 3 years, respectively, revealed little change in species composition from one year to the next, but some fluctuations in density values. The plots are considered representative of open desert scrub of the Chihuahuan Desert. The avifauna of that scrub is shown to be depauperate in relation to that of the deserts of southern Arizona, consisting of species that range widely through the deserts and continguous woody plant formations. Comparison of the avifaunas of several desert areas reveals a relationship between species composition and structural diversity of vegetation. The colonization of desert scrub by euryoecious bird species whose populations were incompletely isolated from those inhabiting other woody plant formations is suggested as a factor that may have hampered the evolution of specializations for life under extreme desert conditions.

LITERATURE CITED

Axelrod, D. I.
1950. Evolution of desert vegetation in western North America. Carnegie Inst. Wash. Publ. 590: 215–306.

Bancroft, G.
1930. The breeding birds of central Lower California. Condor, 32:20–49.

Bartholomew, G. A., and Cade, T. J.
1956. Water consumption of house finches. Condor, 58:406–412.

Bartholomew, G. A., and Dawson, W. R.
1958. Body temperatures in California and Gambel's quail. Auk, 75:150–156.

Behle, W. H.
1943. Birds of the Pine Valley Mountain region, southwestern Utah. Bull. Univ. Utah, 34(2):1–85.
1955. The birds of the Deep Creek Mountains of central western Utah. Univ. Utah Biol. Ser., 11(4):1–34.

Breckenridge, W. J.
1955. Comparison of the breeding-bird populations of two neighboring but distinct forest habitats. Audubon Field Notes, 9:408–412.

Burleigh, T. D., and Lowery, G. H., Jr.
1940. Birds of the Guadalupe Mountain region of western Texas. Occas. Papers, Mus. Zool., Louisiana State Univ., No. 8:85–151.

Chapman, F. M.
1891. On the birds observed near Corpus Christi, Texas, during parts of March and April, 1891. Bull. Amer. Mus. Nat. Hist., 3:315–328.
Davis, J.
1951. Distribution and variation of the brown towhees. Univ. Calif. Publ. Zool., 52:1–120.
Dawson, W. R.
1954. Temperature regulation and water requirements of the brown and Abert towhees, *Pipilo fuscus* and *Pipilo aberti*. Univ. Calif. Publ. Zool., 59:81–124.
Elton, C. S.
1927. Animal ecology (MacMillan, New York).
Fautin, R. W.
1946. Biotic communities of the northern desert scrub biome in western Utah. Ecol. Monog., 16:251–310.
Grinnell, J.
1914. An account of the mammals and birds of the lower Colorado Valley with especial reference to the distributional problems presented. Univ. Calif. Publ. Zool., 12:51–294.
Grinnell, J., and Miller, A. H.
1944. The distribution of the birds of California. Pac. Coast Avif. No. 27:1–608.
Grinnell, J., and Swarth, H. S.
1913. An account of the birds and mammals of the San Jacinto area of southern California with remarks upon the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zool., 10:197–406.
Hensley, M. M.
1954. Ecological relations of the breeding bird population of the desert biome of Arizona. Ecol. Monog., 24:185–207.
Hickey, J. J.
1943. A guide to bird watching (Oxford Univ. Press).
Huey, L. M.
1942. A vertebrate faunal survey of the Organ Pipe Cactus National Monument, Arizona. Trans. San Diego Soc. Nat. Hist., 9:353–376.
Johnson, D. H., Bryant, M. D., and Miller, A. H.
1948. Vertebrate animals of the Providence Mountains area of California. Univ. Calif. Publ. Zool., 48:221–376.
Kendeigh, S. C.
1944. Measurement of bird populations. Ecol. Monog., 14:67–106.
Kluyver, H. N., and Tinbergen, L.
1953. Territory and the regulation of density in titmice. Arch. Neerl. Zool., 10:265–289.
Le Sueur, H.
1945. The ecology of the vegetation of Chihuahua, Mexico, north of parallel twenty-eight. Univ. Texas Publ., No. 4521:1–92.
Miller, A. H.
1951. An analysis of the distribution of the birds of California. Univ. Calif. Publ. Zool., 50: 531–644.
1955. The avifauna of the Sierra del Carmen of Coahuila, Mexico. Condor, 57:154–178.
Miller, A. H., and Miller, L.
1951. Geographic variation of the screech owls of the deserts of western North America. Condor, 53:161–177.
Miller, L.
1943. The Pleistocene birds of San Josecito Cavern, Mexico. Univ. Calif. Publ. Zool., 47:143–168.
Muller, C. H.
1947. Vegetation and climate of Coahuila, Mexico. Madroño, 9:33–57.
Pacific Coast Avifauna
1957. Distributional check-list of the birds of Mexico. Part 2. Pac. Coast Avif. No. 33:1–436.
Phillips, H. W., and Thornton, W. A.
1949. The summer birds of the Sierra Vieja range in southwestern Texas. Texas Jour. Sci., 1:101–131.

Pough, R. H.
1947. How to take a breeding bird census. Audubon Mag., 49:288–297.
Quillin, R. W., and Holleman, R.
1918. The breeding birds of Bexar County, Texas. Condor, 20:37–44.
Shreve, F.
1942. The desert vegetation of North America. Bot. Rev. 8:195–246.
1951. Vegetation of the Sonoran desert. Carnegie Inst. Wash. Publ. 591:xii+192.
Stewart, R. E., Cope, J. B., Robbins, C. S., and Brainerd, J. W.
1952. Seasonal distribution of bird populations at the Patuxent Research Refuge. Amer. Midl. Nat., 47:257–363.
Sutton, G. M., and Phillips, A. R.
1942. June bird life of the Papago Indian Reservation, Arizona. Condor, 44:57–65.
Swarth, H. S.
1920. Birds of the Papago Saguaro National Monument and the neighboring region Arizona (Govt. Printing Office, Washington.)
Thompson, W. L.
1953. The ecological distribution of the birds of the Black Gap area, Brewster County, Texas. Texas Jour. Sci., 5:158–177.
Udvardy, M. D. F.
1958. Ecological and distributional analysis of North American birds. Condor, 60:50–66.
van Rossem, A. J.
1945. A distributional survey of the birds of Sonora, Mexico. Occas. Papers, Mus. Zool., Louisiana State Univ., No. 21:1–379.
Van Tyne, J., and Sutton, G. M.
1937. The birds of Brewster County, Texas. Misc. Publ. Mus. Zool., Univ. Mich. No. 37:1–119.
Williams, A. B.
1936. The composition and dynamics of a beech-maple climax community. Ecol. Monog., 6:318–408.

Department of Wildlife Management, Agricultural and Mechanical College of Texas, College Station, Texas, and *Hastings Natural History Reservation, Carmel Valley, California, March 9, 1959.*

TERRITORIALITY, MOVEMENTS, AND POPULATION DENSITY OF THE DIPPER IN MONTANA

By GERALD J. BAKUS

The main objective of this report is to record quantitative data on territoriality, movements, and population density of the Dipper (*Cinclus mexicanus*) in western Montana. Life history observations have already been published (Bakus, 1959).

I wish to thank Dr. Robert S. Hoffmann for valuable assistance during this study and for generous advice in the preparation of this paper. I am grateful to Dr. Ludvig G. Browman for information on the topography of the Rattlesnake drainage. The efforts of Harold Knapp in assisting me with field work and in giving added advice are appreciated. My sincere appreciation goes to my wife, Grace, who has given freely of her time in the preparation of this material.

DESCRIPTION OF THE STUDY AREA

The study area was located on Rattlesnake Creek, Missoula County, Montana, and extended from its outlet into the Clark Fork River to the upper end of the canyon road, a distance of 13 miles by road. The width of Rattlesnake Creek varies from 10 to about 50 feet. The first half-mile upstream from the Clark Fork River, in an urban area, is intermittently frozen over during the cold winter months and Dippers are not often found there. Above this area, the stream passes successively through a riparian deciduous forest community dominated by cottonwoods (*Populus trichocarpa*), a transitional zone with yellow pine (*Pinus ponderosa*), and a coniferous forest of Douglas fir (*Pseudotsuga menziesii*). Work in the area extended from January, 1956, to August, 1957.

The tributaries that lead into Rattlesnake Creek are usually quite small, brushy, and devoid of Dippers. Even the East Fork of Rattlesnake Creek, which empties into the larger West Fork at an elevation of about 4000 feet (fig. 1) and is 10 to 15 feet wide with a year-round water flow, does not harbor any Dippers so far as is known.

Above the end of the study area the West Fork courses through a steep region of cascading rapids and then flows beneath wind-felled trees. Farther up is a series of brushy areas alternating with several rocky chasms, in which five nests were found. One main tributary supplied by the Rattlesnake Lakes empties into the West Fork in this area. Above this point the streambanks are clothed in dense brush. Wrangle Creek, another main tributary of the West Fork, drains Little and Glacier lakes and must serve as a passageway by a few birds in traveling to these lakes (fig. 1).

Rattlesnake Creek is used by Missoula as a source of some of its water. The Rattlesnake Lakes constitute the primary headwaters of the stream and the levels of many of them are artificially controlled. As the water level of the stream drops during the summer, water is released periodically from some of the lakes.

METHODS AND MATERIALS

Mapping.—A winter study area, representing the lowest 1.7 miles of Rattlesnake Creek, was measured in yards in order to determine accurately individual winter territories. Landmarks at intervals of 50 to 275 yards, such as houses, bridges, trees, and stream bifurcations were used in mapping. For the remainder of the study area the length of road, which follows within 0.25 miles of the stream, was utilized to obtain a total road-stream length by an automobile odometer (fig. 1). Over a period of time certain stream landmarks were recorded and paired with adjacent road landmarks. A map was then drawn to scale representing the 13 miles of stream.

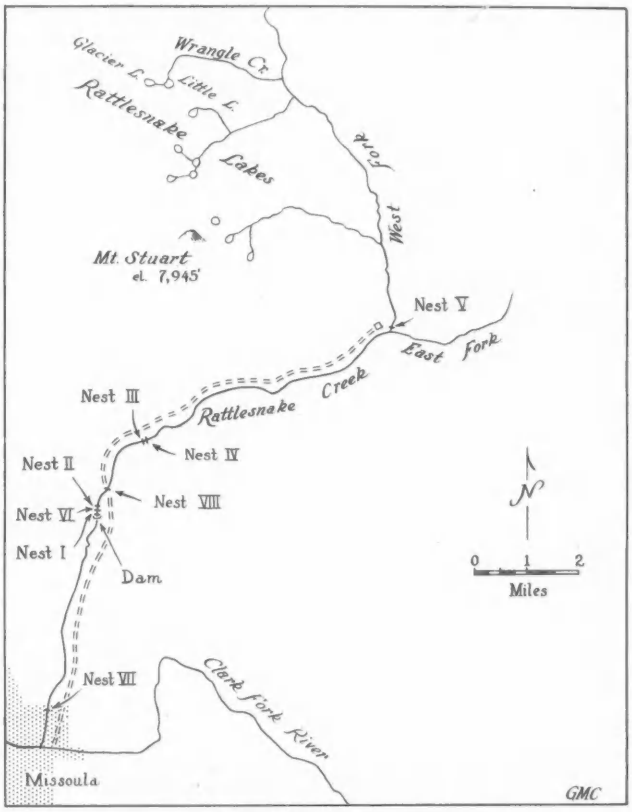


Fig. 1. Map of the Rattlesnake Creek drainage.

Trapping and banding.—Trapping was done with a number 5 Japanese mist net which was 38 feet long and 7 feet high when fully extended and had mesh openings of one square inch. The net, mounted between two poles, was placed across the stream in the vicinity of a Dipper. The observer then attempted to chase the bird into the net. The success of the procedure and the time it required varied with the topography and weather. During the winter, when the net threads froze together as they came in contact with the water, more than an hour was sometimes needed to effect a capture. Correct tension on the net was also important (see Low, 1957). After practice, however, the technique proved to be at least 75 per cent effective.

One difficulty encountered was the relationship of the territory of the bird to be trapped to the position of the net. Several times a Dipper was observed, the net was set in position, and an attempt was then made to chase the bird into the net. The bird would move only so far and then suddenly reverse its direction and fly away from the net. I believe, in these instances, that the net was actually outside of the individual's territory.

During the first few months of trapping five birds were marked only with combina-

tions of Fish and Wildlife Service aluminum bands, size 1-A. A red plastic neck band (Craighead and Stockstad, 1956) was placed around the neck of bird no. 2 on February 11, 1956. The Dipper was not seen after this and may have succumbed because of the band's ruffling of neck feathers which allowed water penetration. In early April, 1956, split celluloid rings of three separate colors, yellow, orange, and red were used in various color combinations along with the Fish and Wildlife Service bands. The particular colors chosen were satisfactory, but occasionally there was some difficulty in distinguishing red and orange if they were placed together on one leg. Nestlings were also banded using the same markers.

Observations and census techniques.—Observations were made with the aid of 7×50 binoculars. The colors of the celluloid markers could be identified with certainty only if the birds were within about 30 yards of the observer. On several occasions it took as long as 15 minutes to determine the color combinations because of the evasive behavior shown by the bird. During most of the year the stream could be followed by walking along the bank. However, many times during the summer I walked directly in the stream and during July and the first part of August I was able to float down parts of the stream on a rubber raft.

Dippers could usually be flushed as I walked along the shoreline. However, sometimes birds would stand motionless until I had passed and then fly, giving alarm calls. My censuses were thus made using a combination of sight and sound records. The greatest errors occurred during the high water season in April, May, and June because the noise of the turbulent water prevented the calls of a flushed bird from being heard. In the spring of 1956, much of the upper five miles of the study area was flooded by the stream rising above its banks and creating numerous channels. These inundated areas made it difficult to approach the main stream. Thus, portions of the main stream could not be reached and the birds were not counted in these areas at that time.

Additional censusing errors occurred during the winter on frozen portions of the stream. Batchelder (1885:236) noted Dippers swimming downstream under ice and

Table 1

Dippers (*Cinclus mexicanus*) Observed in the Winter of 1956–57

Date	No. birds known in winter study area	Number designations of birds in order found	Per cent observed
Dec. 20	7	21, 3, 18, 20, 17	71.5
Dec. 29	7	1, 3, 19, 20, 17	71.5
Jan. 11	6	1, 21, 19, 18, 20, 17	100.0
Jan. 16[2]	6	1, 21, 18, 17	66.7
Jan. 21	5	1, 19, 18, 20, 17	100.0
Jan. 28	5	1, 19, 18, 20	80.0
			Average observation efficiency 82 per cent
Feb. 6[3]	3	1, 19	66.6
Feb. 9	3	19	33.3
Feb. 16[4]	3	19, 18	66.6
Feb. 23	4	17, 1, 19	75.0
March 2	4	19	25.0
March 6	4	1, 19, 18, 17	100.0
			Average observation efficiency 61 per cent

[1] Bird no. 3 last seen on this date.
[2] Bird no. 21 last seen on this date.
[3] Bird no. 20 was observed upstream at the Montana Power Company dam.
[4] Bird no. 17 was observed upstream at the Montana Power Company dam.

Murie (1946:260) stated that many times during winter they disappeared under ice overhanging the water. Frequently during winter I failed to observe some previously marked birds on a frozen stretch of stream, presumably because of their "under-ice" activities. On January 14, 1956, a Dipper when chased upstream about 200 yards flew under an ice ledge. An attempt to locate the bird was unsuccessful until it suddenly appeared five minutes later. On January 16, 1957, a Dipper flew into a small opening in an icy stretch and remained there until I walked over to the opening and flushed the bird out. In the winter of 1955–56, this type of census error was thought to be roughly 20 per cent. However, this was based on a relatively small number of birds and days of observation (fig. 3). The winter of 1956–57 was belated but very severe. During February many parts of the winter study area were frozen over. Under normal conditions an average of 82 per cent of the birds known to be on the winter study area were observed on any one day, but in February only 61 per cent were seen on any single observation day (table 1). The greatest accuracy in censusing was achieved from July to November when the observer walked or floated down the middle of the stream and more birds could be flushed and counted.

TERRITORIALITY

The Dipper is one of the few North American birds which exhibits a strong winter territorial defense. Individuals defend territories confined to the watercourse and its banks, and the limits of the territory constitute a strong psychological barrier which is seldom trespassed.

Territorial behavior.—Intraspecific territorial defense was seen many times on the winter study area. Observed behavior is nearly the same whether a bird was chased by the observer into another's territory or flew into its neighbor's territory of its own volition. If bird A, for example, comes near bird B in the latter's territory, both will take a territorial defense position. This consists of stretching the neck out with the head high in the air. If on the same rock, they then may walk around in a circular fashion, with wings raised, facing each other directly. An alarm call, a song, or a combination of the two may be given. Many times they cease their territorial display and begin foraging. This is perhaps displacement behavior. If the territorial strife is severe, they may quickly peck one another, with accompanying body and wing motions. This usually results in B chasing A well back into A's territory and then returning to its own territory.

If A, instead of gradually approaching, flies rapidly past B, B will usually pursue A and fighting may occur in flight. In most instances, a bird that invades another's territory is driven back. Sometimes A may fly completely over and beyond B's territory with B giving up the chase. If B sees the observer chasing A, both A and B may fly away together. On several occasions during the year I have pursued groups of as many as three birds in this manner.

The occurrence of interspecific defense behavior was occasionally observed. On January 28, 1958, a Dipper was seen approaching a Robin (*Turdus migratorius*) which was drinking from the stream. The Dipper assumed a territorial defense posture but no fight occurred. It may be that the Dipper mistook the Robin for another Dipper until it approached near enough to recognize that it was another species. On May 20, 1956, around nest III, a Spotted Sandpiper (*Actitis macularia*) was actively pursued by a Dipper, presumably the male of nest III (fig. 1). This was the only observed case which even suggested defense of the breeding territory or nest.

Behavior toward the observer.—Vogt (1944:38) discussing the Water Ouzel (*Cinclus cinclus*) designates four behavior patterns observable when the bird is approached by a human: perception, awareness, agitation, and flight, in that order. He states that

the perception distance of the bird and its reaction to the observer are unknown. The bird becomes aware of a person at about 45 yards and eyes the "intruder," sings, or resumes foraging. It becomes agitated at 35 yards and dips rapidly or may hop around and give an alarm call. At 30 yards the bird takes flight, usually giving an alarm call.

In the present study, there was a large variation in the observer-bird distance at which these behavior patterns were noted. Variation is due to season as well as to individual differences. At cold temperatures (usually below 10°F.), it is sometimes possible to approach within 10 feet of a bird before it shows signs of agitation. Usually, in warmer weather, birds were approached within 30 yards before they showed awareness, 20 yards before they displayed agitation, and 15 yards before they took flight. In some instances, however, it is impossible to approach within 50 yards of a bird without its taking flight. The awareness distance depends largely upon the position of the person in relation to the bird. Under favorable conditions, the Dipper is evidently aware of a person at a distance of at least 100 yards. This is substantiated by William Goodge (MS) who, in making an anatomical study of the Dipper, found that the bird had emmetropic or normal vision both in air and underwater.

Dippers frequently give an alarm call when approached, although during winter and spring, a mixture of song and alarm cry, or occasionally only the song, may be heard. Closer approach often elicits an alarm cry, followed by movement away and by hurried feeding, which may be a type of displacement behavior. If one walks rapidly or runs toward the Dipper, it flies off with an alarm call, and it may then be chased ahead for a short distance, for hundreds of yards, or it may even fly in the opposite direction from which it is being chased. It most commonly can be pursued for a distance of from 50 to 300 yards. It is very difficult to predict in what direction the bird will move. It seems to depend upon the position of the bird in relation to its territory and the position of its territorial neighbor at the time of the chase.

MOVEMENTS

Stream surveys.—During this study seven complete stream surveys were made in order to show exact distribution of the Dippers and to correlate data on movements of marked birds with movements of the total population. An explanation of these is presented in the section on population density (see p. 421). The data on movements of banded birds was corroborated by the stream censuses. The seven surveys are shown in linear form in figure 2.

Winter.—Winter territories of the Dipper were established in November, and territorial defense was strongest from November through February. A number of territorial fights was observed. Several of these were accompanied by loud singing, and singing was prevalent during this period. Territorial size varied considerably. A minimum of approximately 50 yards was observed on January 28, 1957, when four Dippers were occupying an open 233-yard stretch bounded by anchor ice at both ends. The maximum was nearly one-half mile, as in no. 17, which had a large open area with little, if any, territorial defense needed (fig. 4).

Many authors (Sclater, 1912; Skinner, 1922; Dawson, 1923; Ehinger, 1930; and others) have mentioned the territoriality of the Dipper. Vogt (1944:36) states that the winter territory of *Cinclus cinclus* in Switzerland varies between 200 and 500 meters in length, and that, in general, territorial limits are definite and rarely change. He adds that occasionally alien ouzels without a territory appear on the study area and are chased off by the resident birds.

In February of 1956, five birds were banded on the winter study area (numbers 1, 2, 3, 4, and 5). Bird no. 2 was also experimentally marked with a plastic neck band and

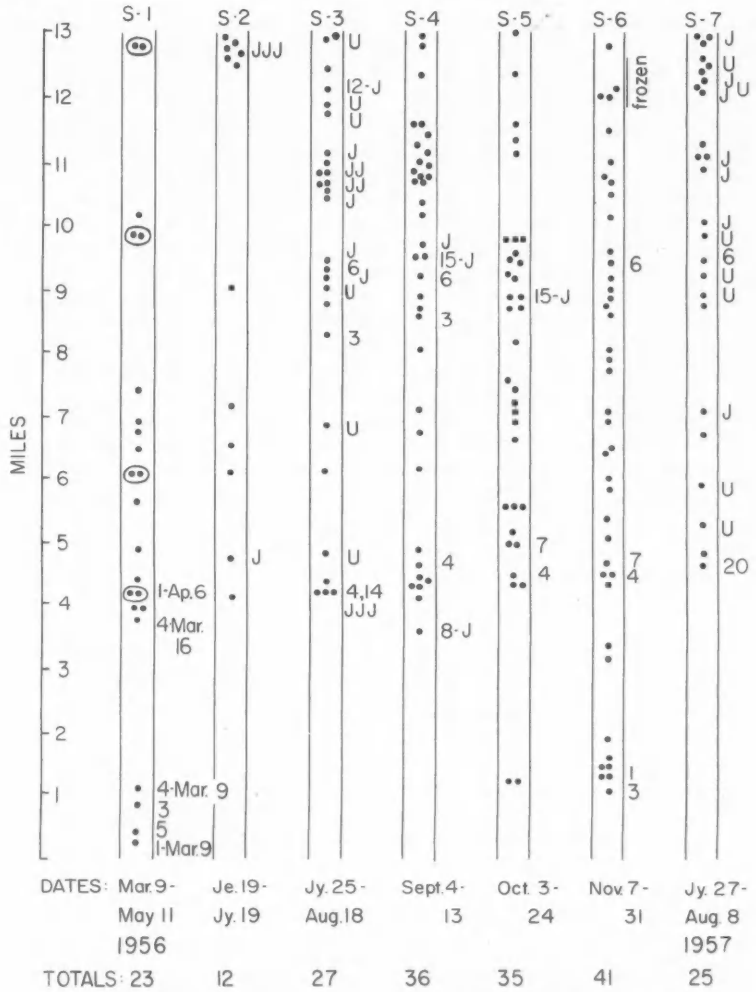


Fig. 2. Stream surveys taken during the study. Survey 7 was an additional check on the postbreeding population. Legend: S = survey; U = undetermined status; two circled dark spots = paired birds; J = juvenal bird.

was not observed again. The birds tended to remain in the following order, reading upstream: nos. 1, 5, 3, and 4. Number 3 was upstream from no. 4 when banded. On February 19, 1956, an unbanded bird was seen and remained upstream from no. 4 on all subsequent observations. On frequent occasions the birds were chased in order to determine how extensive their territories were by observing territorial fights. However, my pursuit many times resulted in two or sometimes three birds flying off in a group without

at first showing any territorial defense. Pursuit resulted in four position reversals of short duration; only once after banding did a shift in territorial position occur which was not the result of my chasing one bird into another's territory; no. 1 was found above no. 5 on February 25 (fig. 3). The reason for the shift is not known. There was some evidence of small daily movements in the total population. In two surveys, when the stream was checked twice in one day, it was found that the group of birds had moved downstream about 50 to 75 yards by afternoon but had maintained their original order.

On October 7, 1956, two unbanded birds were the first Dippers seen in the winter study area in the winter of 1956–57 (fig. 2). They had moved from the upper reaches of the stream. By November, 1956, nos. 1 and 3, and two additional unmarked birds had entered the winter study area (figs. 2 and 4). Six birds were banded in December (nos. 17, 18, 19, 20, 21, 22). However, no. 22 was marked 50 yards beyond the end of the area under observation. Both nos. 21 and 22 had difficulty in flying after being marked. This is attributed to wing injury received upon hitting the mist net. The order of the birds throughout the winter period was, beginning with the downstream position: nos. 1, 21, 3, 19, 18, 20, and 17. With the disappearance of no. 3 after December 29 and of no. 21 after January 16 the order of birds was: nos. 1, 19, 18, 20, 17 (fig. 4). After banding, the birds maintained their order of territorial possession even if upstream or downstream

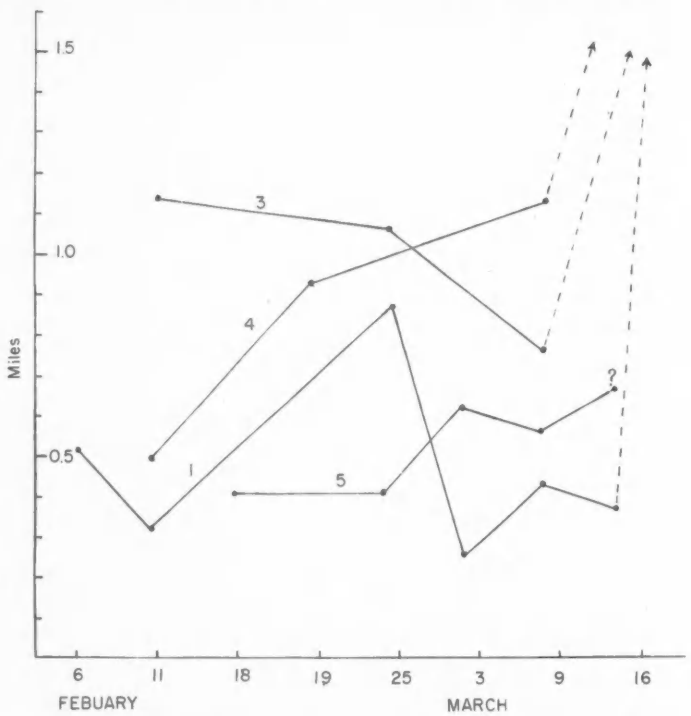


Fig. 3. Movements of banded Dippers in the winter study area in the winter of 1955–56. The arrows indicate that the birds were observed upstream at a later date.

movements of the whole population occurred. The only exception was no. 17, which was found below no. 1 on February 23, 1957 (fig. 4). This was attributed to a period of cold weather (see beyond). In contrast to the previous winter no pursuing of birds was done in order to compare the two different approaches in obtaining winter territorial data.

In both winters movements of Dippers were frequently restricted in the winter study area during periods of cold weather. At these times the lowest 500 yards of the creek were frozen over almost completely and birds in the remaining open areas were somewhat isolated by intermittent frozen stretches of stream. The water level was low at this time; the rate of flow during December ordinarily varies between 30 and 75 cubic feet per second (personal communication, Montana Power Company). Beginning on January 16, 1957, the lowest 950 yards of Rattlesnake Creek were frozen over. This resulted in a clustering of four birds (nos. 1, 19, 18, 20) within a 253-yard stretch of stream (fig. 4, January 21). Following this there was a short period of intense cold with minimum temperatures of −25°F. on the 25th, −33°F. on the 26th, and −31°F. on the 27th of January. The maxima of January 28 and 29 were still well below zero. As a result, not one bird was seen on the first five miles of the stream when it was checked on January 30 (fig. 5). The stream was frozen solid except for three small openings along this five-mile length. It is known that temperatures were higher at greater elevations due to an inversion phenomenon and it is probable that the birds were forced upstream to open water, as no birds were observed on the Clark Fork River (fig. 1). This hypothesis is

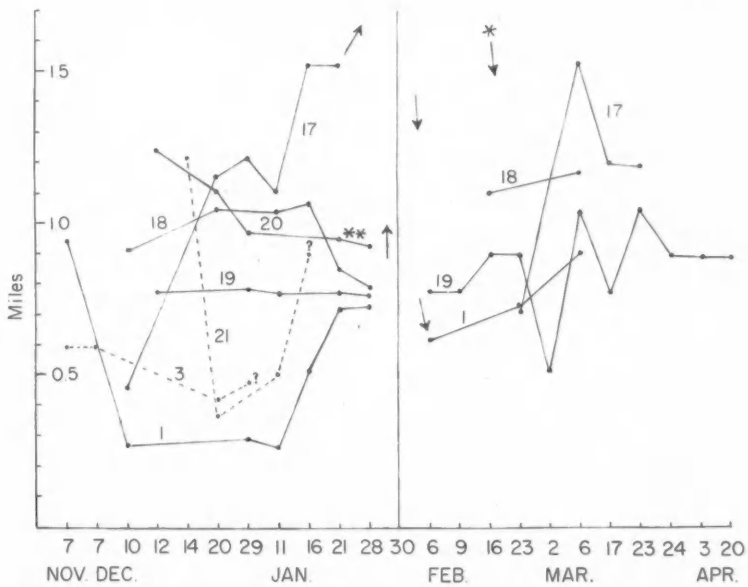


Fig. 4. Movements of banded Dippers in the winter study area in the winter of 1956–57. Intermittent lines represent birds that were observed for short periods of time. Arrows show probable movements during and after the freeze in late January. * Bird 17 (Feb. 16) observed 3 miles upstream from previous location. ** Bird 20 (Feb. 16) observed 3 miles upstream where it remained.

supported by the fact that nos. 17 and 20 were found three miles upstream, near the dam, during the thaw which followed the cold spell. A week later no. 17 had returned to the winter study area but no. 20 remained near the dam (fig. 5).

Spring.—Between March 10 and 16 in 1956 upstream movements began. Bird no. 4 had moved up 2.6 miles and was paired with another bird. Bird no. 1 had moved 3.2 miles upstream. By March 20, all birds had moved from the winter study area (fig. 5). Upstream, other unmarked paired birds were observed. However, solitary birds were observed upstream as late as April 21, 1956. Birds no. 6 and no. 7 were banded in April. On April 23, no. 6 was found in nest I, and it was mated to no. 4. Number 7 and an unbanded bird were feeding young in nest II. Nest III (unbanded parents) had nestlings

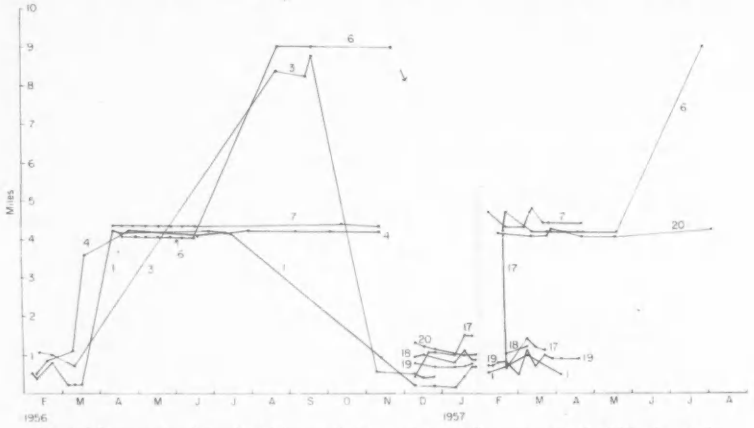


Fig. 5. Movements of banded Dippers that were frequently encountered within the study area. The stippled band (Jan. 30, 1957) indicates that at least 5 miles of stream were completely frozen.

and nest IV had a pair of unbanded birds (fig. 1). A pair of birds was seen copulating across from nest IV on May 23 and a female was found in the nest on June 6. However, on June 14, no parent was in the nest and no brood was raised. A bird was once found in nest V but apparently it raised no young.

Nestlings no. 8, 9, 10, 11, and 12 were banded from nest III on May 7 and nos. 13 and 14 were banded from nest I on May 19 (fig. 1). Four fledglings were seen on May 23 from nest III, four on June 6 from nest II, and two on June 14 from nest I. The fledglings were very gregarious, being observed in groups of two, three, or even four, on rare occasions.

In the spring of 1957 birds no. 23 and 24 were banded on March 9. On the same day, previous to the marking of these two, the first observed pairing of birds occurred between no. 7 and either no. 23 or 24. However, this was temporary as no. 7 was seen to be paired with an unbanded bird on March 28. This indicates that some birds may change mates during the early pairing period. Numbers 19 and 1 both were paired with unbanded mates within the winter study area in early April (fig. 5). This spring season differed from the previous one in that two pairs of birds remained in the winter study area, one pair (no. 19 and mate) constructing nest VII (fig. 1). The unbanded mates of nos. 1 and 19 had moved downstream into the winter study area as contrasted with unidirectional movement out of the winter study area in the spring of 1956. However, by May 6, 1957,

no birds were found within the winter study area, probably because they had moved upstream, and nest VII was deserted. Bird no. 6 (nest I) and no. 7 (nest II) both returned to their previous year's nesting site and initiated nesting activities (fig. 5). Nest III again had a pair of unbanded nesting birds. April 1 was the last date on which winter territorial defense was noticed. By April 5, all the birds observed in the lowest six miles of Rattlesnake Creek were paired but on May 5, about one mile above the upper limit of the study area, a solitary bird was seen. This observation plus other nesting data indicate that nesting activities, including pairing, commence later at higher elevations. No observations were carried out this season on the dispersal of fledglings and adults.

During the two spring seasons the water level remained low until April. Several erratic thaws then resulted in temporarily torrential waters. The stream reached its yearly peak around May 19, 1956. During an average year this amounts to a flow of about 2100 cubic feet per second (personal communication, Montana Power Company), but this figure does not include water consumed by Missoula or used for irrigation purposes along the lower Rattlesnake Creek drainage. The stream receded slightly on May 26, and by June 28, 1956, it could be crossed at many points. The spring of 1957 differed in having less water. It appears that the nesting of those birds observed was correlated with the high water period. This may perhaps give the nestlings and fledglings an additional margin of security against potential predators.

Only a few territorial defenses were recorded in March and April. The transition in 1957 from winter defense to pairing, with no observed defense, took a minimum of 12 days for bird no. 19, 19 days for no. 7, 22 days for nos. 6 and 20, and less than a month for no. 1. Number 6 showed slight indications of territorial defense against her mate (no. 20), when rapidly approached, even after the inner lining had been placed in the nest. During the nesting period no intraspecific strife was observed. This is attributed to the fact that most breeding pairs were widely separated from one another; also the breeding defense may be weak. Hann (1950:57) says that the parent Dipper does not ordinarily invade the territory of another. On one occasion he observed a parent expressing "dissatisfaction" toward an alien Dipper by fluttering and scolding. Another time there was only "disapproval."

Hann (*op. cit.*:52) mentions that food for the young is obtained as far as 400 yards downstream or upstream from the nest. Cordier (1927:173) has observed adult Dippers gathering food one-half mile down from the nest. My observations differ; no. 6 had the largest observed breeding territory and was found only as far as 150 yards upstream from nest I and as much as 200 yards downstream for a total of 350 yards.

Bent (1948:109) states that during the nesting season territories are extensive with nests being a mile or more apart. Grinnell and Miller (1944:328–329) note that along an especially favorable stream four breeding pairs have been found in one mile. Hann (*loc. cit.*) gives the size of nesting territories of the Dipper as about one-half mile in length. He relates two cases in which nests were abandoned and says that these may be due to the proximity of other pairs of Dippers 400 yards and one-half mile, respectively, from the nests. However, he apparently had no evidence from banded birds and the present study indicates that two functional nests may be found within 250 yards of each other. On Rattlesnake Creek three pairs of nests were located in which members of the pair were within 50 yards of one another. Three additional nests (nests I, VI, and II) were all placed within 250 yards of each other, and two of the three were occupied.

Summer.—By June 15, 1956, most of the fledglings and adults had dispersed from the breeding sites (fig. 5). Hann (1950:56) states that fledglings ordinarily were found within the nesting territory during the first three days. They rapidly dispersed up to a mile within a week. My observations show that the dispersal of Dippers took place

within the first two weeks. In 1956, no birds were observed within three-fourths of a mile of nest III in either direction six days after fledging, dispersal having begun after four days.

Some solitary adults, juveniles, and occasionally duos of juveniles were seen during June in the first 9 miles of the study area. In the last three miles, where nesting was not studied, several groups of adults with young were observed in July. This would suggest a later breeding upstream. Bird no. 15, a fledgling, was banded near the 12.6-mile point on July 18 and two other fledglings were also observed in the area. Three days later no. 16, another fledgling, was banded in the same area. Since no. 15 and several other fledglings could not be found on the uppermost three-fourths of a mile on July 21, it was thought that the birds might have moved downstream. During early August, no. 4 (adult) and no. 14 (juvenile) were observed below nest II (figs. 2 and 5). This signifies that some adults and juveniles remain near the nesting site.

Frequently groups of two or three birds were observed during July and August and a reduction in the number of Dippers on the first five miles was noticeable. There was an evident concentration of birds on the upper five miles of the study area (fig. 2). Number 12 (juvenile) was observed on August 17 about one mile below the upper end of the study area, having moved upstream about six miles. Number 6 had likewise moved upstream a total of five miles (fig. 5). Number 3 had not been observed after March 9, 1956, but it was now found almost eight miles upstream (fig. 5). A sizable upstream movement had thus taken place from the lower half of the study area.

In early September there were at least as many birds on the upper three and one-half miles as in August (fig. 2). Number 4 (adult) remained near nest II. Number 3 (adult) was found in the same general upstream area as in August. Number 8 (juvenile) was observed on September 13 for the first time since fledging and was at the 3.3-mile point, which was below its birthplace (fig. 2). This may indicate that a few fledglings disperse downstream although most of the birds tended to move into the upper half of the study area. Number 15 (juvenile) was observed to have moved downstream about three miles since July 18 (fig. 2). This supports the hypothesis that some of the fledglings near the upper end of the study area moved downstream after fledglings on the lower area had moved upstream. These movements resulted in a concentration of young and adults between the 8- and 12-mile points (fig. 2).

During this summer period individual preference was exhibited toward a given area of stream. The extent of this area varied greatly, the maximum observed being about one-half mile. No territorial defense was noted, and no singing was heard from the time of fledgling dispersal until September 11, 1956. Dippers were commonly seen in groups of two or three or they were solitary, young birds tending to be especially gregarious. Bird no. 6, in 1957, returned to the same summer area in which it was found in 1956 (fig. 5).

Late summer observations on other areas.—A check on the West Fork of Rattlesnake Creek, beyond the upper boundary of the study area, was first made on August 24, 1956, in order to see if any banded birds had moved that far upstream (fig. 1). On that date two solitary Dippers were observed within the first mile above the end of the study area. On September 1 and 5, an additional seven miles of stream was covered. Twelve birds were seen, some solitary and some in groups of two. None was banded and no territorial defense was shown.

Seven of these birds appeared to be young juveniles. This, together with observations previously given, is interpreted to mean that nesting occurred later in this upper area; that is, nesting begins on the lower half of the study area and proceeds upstream as the season progresses.

Just preceding the autumn season Little Lake and Glacier Lake, two of the 20 or more Rattlesnake Lakes, were visited (fig. 1). On September 16, 1956, two Dippers were observed on Little Lake (elevation 6500 feet). One pursued the other around the shoreline for about one-fourth mile and sang loudly while in flight. On September 17, two Dippers were found on Glacier Lake (elevation 7000 feet). Each was chased about 250 yards before turning back but displayed no territorial defense. The birds found on the lake shores exhibited habitat preferences similar to those of a stream bird.

Fall.—On October 7, 1956, two unbanded birds were observed within the winter study area, and an abundance of birds was seen between the 5-mile and 9.5-mile points (fig. 2). Downstream movement was in progress. Number 15 had moved down about one mile since September 11 (fig. 2). Dippers were still found in pairs and groups of three, and also as solitary birds. However, the occurrence of one territorial fight and increase in the frequency of singing was evidence for the commencement of fall-winter territoriality. Bent (1948:105–106) mentions that Dippers are very rarely seen in groups. My studies, however, have shown that they are commonly gregarious during the summer post-breeding period and throughout the first half of the fall season.

By November 7, 1956, a total of six birds had moved downstream into the winter study area (fig. 2). Among these was no. 3, an adult from the previous winter, which had moved downstream 8.3 miles within two months and no. 1, another old adult, which had moved downstream three miles since July 12, 1956 (fig. 5). Number 4 was still near the dam, having remained in that area throughout the spring, summer, and fall, as did no. 7 in the region of nest II. Number 6 remained up near the 9-mile point for an undetermined period of time before returning to the dam (fig. 5). Dippers were fewer on the uppermost three and one-half miles, abundant on the next four and one-half miles, and showed a large increase over October on the lower five miles (fig. 2). Territorial defense again became widespread among the Dippers, and more songs were heard. The majority of birds observed were solitary and those near one another had territorial fights. A summary of the numbers of birds and their movements throughout the summer and fall of 1956 is given in table 2.

POPULATION DENSITY

Spring-summer, 1956 and 1957.—The first complete survey of the study area (No. 1) took place during the pre-nesting and nesting period from March 9 to May 11. A total of 23 presumably different adults was observed. Five pairs were seen; pairs appeared more commonly on the upper part of the study area because that region was observed at a later date (fig. 2). Because of two high-water periods which made some sections of the uppermost five miles of stream inaccessible, and because of the length of time involved, the total number of birds counted is unreliable as a census. Some birds were undoubtedly missed and others were probably counted twice.

A post-nesting survey (No. 2), June 19 to July 19, was made from about the 4- to the 13-mile points as no birds were present at that time below the 4-mile point. An increase in the total number of birds would be expected, but only eight adults and four juveniles were observed (fig. 2). The noise in mid-June from the rushing water still prevented birds from being heard, in some cases, even if accidently flushed.

Another survey (No. 3) was conducted from July 25 to August 18. A total of 27 Dippers, including 9 adults, 12 juveniles, and 6 birds of undetermined status, was observed (fig. 2). Water level was low at this time and the census was made by either walking or floating down midstream.

A comparable survey (No. 7) was carried on from July 27, 1957, to August 8, 1957. This was an additional check on the Dippers during the post-breeding season. A total of

25 birds was counted including 11 adults, 7 juveniles, and 7 birds of undetermined status (fig. 2).

Survey 4 from September 4 to September 13, 1956 (walking midstream) was considered to be more reliable. Three juveniles, two of which were banded, and 33 adult or adult-like birds were observed (fig. 2). The decrease in proportion of juveniles on this survey is attributable to the fact that most of them had acquired adult plumage.

Fall, 1956.—Survey 5 from October 3 to October 24 (walking midstream) resulted in 35 birds being observed (fig. 2). The duration of the survey was longer than the previous one but the total number of birds remained almost the same.

Table 2

Numbers and Movements of Dippers in 1956

Survey no.	Area (road mi.)	No. of birds	Per cent of total	Dates
3	1–5	5	18	July 25, 26, 28
	5–9½	8	30	June 25, 28; Aug. 17, 18
	9½–13	14	52	Aug. 17, 18
		Total 27		
4	1–5	8	22	Sept. 4, 13
	5–9½	8	22	Sept. 4, 7, 8, 11
	9½–13	20	56	Sept. 11
		Total 36		
5	1–5	8[1]	23	Oct. 3, 5, 7
	5–9½	19	54	Oct. 13, 17
	9½–13	8	23	Oct. 19, 24
		Total 35		
6	1–5	14[2]	34	Nov. 7, 9
	5–9½	17	42	Nov. 14, 21
	9½–13	10	24	Nov. 28, 31
		Total 41[3]		

[1] Two birds were seen in the winter study area at this time.
[2] Six birds were seen in the winter study area at this time.
[3] Total of survey 6 was greater than that of 4 and 5. This may have been due to an influx of birds from above the study area or duplications in counting as downstream movement was occurring at this time.

Survey 6 was conducted from November 7 to November 31. Forty-one birds were observed (fig. 2). Since downstream movement was in progress the increased number of birds may have been due to an influx of Dippers from above the study area.

Winter, 1955–56 and 1956–57.—During the winter of 1955–56 in the winter study area, six birds were observed within a span of 2280 yards for a mean density of one bird per 380 yards or 0.216 mile. During February and March an average of 80 per cent of the birds was observed on any one day. Only on one occasion were all the birds seen. This indicates a considerable survey error. However, these percentages are based on eight censuses.

During the winter of 1956–57, seven birds were observed on the winter study area. They were found within a span of 2425 yards for a mean density of one bird per 346 yards or 0.197 mile. From December 14 through January 28 an average of 82 per cent

of the birds was observed on any one census. On January 30 the first five miles of stream were completely frozen over. From February 6 through March 6, with fewer birds on the winter study area, the average observed on any census was about 61 per cent (table 1). This increased error may be the result of the frozen condition of the stream in which the birds would stand unnoticed in small ice openings or under ice ledges.

Interpretation.—Under conditions of the winter study, it was found that about 82 per cent of the birds present on the study area were observed on any one day. Conditions for censusing from the 1.7- to the 13-mile points were not as favorable as that of the winter study area. However, if it is assumed that 82 per cent of the birds can be observed, and if this correction is applied to the pre-nesting survey (No. 1), then the total pre-nesting population in 1956 would be roughly about 27 birds for a mean density of one bird per 0.481 road-stream mile. Road and stream lengths are considered to be approximately the same since meanderings of the stream are compensated for by bends in the adjacent road. The first post-nesting survey (No. 2) is inadequate to show the population increase during the breeding season, but the remaining five surveys are more reliable. The corrected population for survey 3 is approximately 32 birds. This is a density of one bird per 0.406 road or stream mile. A similar adjustment of the post-nesting survey of 1957 (survey 7) results in a total of 30 Dippers on the study area, for a density of one bird per 0.433 road-stream mile.

The calculated pre- and post-nesting populations of the study area indicate a population increase of at least five birds during the 1956 breeding season. However, on the basis of observed marked and unmarked, fledged Dippers, the juvenile increment amounted to about 14 birds in 1956 and 11 birds in 1957. The difference might be attributed to the disappearance of about ten adult Dippers between pre- and post-breeding surveys. This interpretation is supported by a decline of this magnitude in the number of adult birds seen over this period. On the other hand, surveys 4 and 5 indicate a corrected population of 42 Dippers, or one bird per 0.310 road-stream mile. This value may more accurately represent the post-breeding population and indicates a spring to fall population increase of 15 during the 1956 breeding season. However, the figure may also include individuals which have recently entered the study area from above.

Other areas.—On September 1 and 5, 1956, a total of 14 birds was observed on eight trail-miles of stream beyond the end of the study area. This is a density of one bird per 0.571 trail-stream mile (fig. 1). It is believed that some of these upper areas freeze over more or less completely during the winter, forcing some of the birds down to lower regions.

It has been observed that Dippers tend to congregate about restricted open waters in winter (Warren, 1914; Dawson, 1923). Skinner (1922:20) compared the number of birds on the lower six miles of the Gardiner River in Yellowstone National Park, which supported a population of 75 in winter and about 10 during the summer. These reports and additional data from Rattlesnake Creek seem to indicate that increased density of Dippers on the lower parts of streams and rivers during winter occurs over much of their range.

SUMMARY

Territoriality, movements, and population density of Dippers (*Cinclus mexicanus*) were studied from January, 1956, through August, 1957, on Rattlesnake Creek, Missoula County, Montana. Nestlings, juveniles, and adults were color-banded or otherwise marked. Of 28 banded birds, 21 were seen at least once at a later date and 9 were observed for a considerable length of time.

The winter territories were established in November, and territorial defense was

strongest from November through February. Territories range from 50 yards to as much as one-half mile. The birds tend to maintain their respective positions on the stream. Shifts result from extremes in weather which result in stream-ice formation and thawing.

In March, a general movement of birds away from the lower reaches of the stream occurred. A two- to four-week transition from winter defense to pairing, with no territorial defense, took place. During the nesting period little, if any, territorial defense was shown, but most breeding pairs were well separated from one another. The maximum extent of the breeding territory was about 350 yards.

During June most birds tend to disperse, primarily upstream from the lower half of the study area. Dispersal downstream from the upper reaches of the study area occurred in July, as a later nesting season is typical of birds found at higher elevations. The effect of these movements was a marked concentration of birds above the 9½-mile point of the study area during August and September. Preference is then exhibited toward a chosen area of stream but without territorial defense.

General downstream movement occurred in October with the greatest number of birds observed between the 5- and 9½-mile points.

A concentration of Dippers on the lowest five miles of the study area was observed in November. The remainder of the stream showed relatively small change. This may indicate the possibility of an influx of birds from higher elevations as winter weather begins. Several birds returned to the site of their previous winter territory. Others remained for the duration of the winter in the area where they had previously nested.

Assuming a census error of about 18 per cent, the total pre-nesting population in 1956 was about 27 birds for a mean density of one bird per 0.481 road-stream mile. The post-nesting population in 1956 was approximately 32 for a mean density of one bird per 0.406 road-stream mile, and about 30 in 1957 for a mean density of one bird per 0.433 road-stream mile. However, on the basis of observed marked and unmarked, fledged Dippers, the population increase amounted to about 14 birds in 1956 and 11 birds in 1957. Winter density was one bird per 0.216 stream mile in 1955–56, and 0.197 stream mile in 1956–57, for the lowest 1.7 miles of Rattlesnake Creek.

LITERATURE CITED

Bakus, G. J.
1959. Observations on the life history of the dipper in Montana. Auk, 76:190–207.

Batchelder, C. F.
1885. Winter notes from New Mexico. Auk, 2:233–239.

Bent, A. C.
1948. Life histories of North American nuthatches, wrens, thrashers and their allies. U. S. Nat. Mus. Bull. 195.

Cordier, A. H.
1927. Some observations on the water ouzel. Auk, 44:169–178.

Craighead, J. J., and Stockstad, D. S.
1956. A colored neckband for marking birds. Jour. Wildlife Manag., 20:331–332.

Dawson, W. L.
1923. The birds of California. 4 vols. (South Moulton Co., San Diego).

Ehinger, C. E.
1930. Some studies of the American dipper or water ouzel. Auk, 47:487–498.

Grinnell, J., and Miller, A. H.
1944. The distribution of the birds of California. Pac. Coast Avif. No. 27:1–608.

Hann, H. W.
1950. Nesting behavior of the American dipper in Colorado. Condor, 52:49–62.

Low, S. H.
1957. Banding with mist-nets. Bird-banding, 28:115–128.
Murie, A.
1946. Observations on the birds of Mount McKinley National Park, Alaska. Condor, 48:253–261.
Sclater, W. L.
1912. A history of the birds of Colorado (Witherby and Co., London).
Skinner, M. P.
1922. Notes on the dipper in Yellowstone National Park. Condor, 24:18–21.
Vogt, W.
1944. Ueber die Territorien der Wasseramsel *Cinclus cinclus* (L.), im Winter 1943/44 an der Aare bei Bern. Der Ornithologische Beobachter, 41:36–43.
Warren, E. R.
1914. Some winter bird notes from Yellowstone National Park. Auk, 31:546–548.

Department of Zoology, Montana State University, Missoula, Montana; present address, Department of Zoology, University of Washington, Seattle, Washington, May 27, 1959.

BODY TEMPERATURE AND THE ONTOGENY OF THERMOREGULATION IN THE SLENDER-BILLED SHEARWATER

By DONALD S. FARNER and D. L. SERVENTY

Although a fairly substantial amount of information has been accumulated on body temperatures and thermoregulation in birds, our knowledge of the Procellariiformes in this respect is meager (Farner, 1956). Consequently it appears desirable to present an analysis of a series of data obtained on the Slender-billed Shearwater (*Puffinus tenuirostris*) from some of the nesting colonies on islands in Bass Strait, Australia.

Among previous investigations of the Procellariiformes only those of Folk (1949, 1951) on the Leach Petrel (*Oceanodroma leucorhoa*) and Farner (1956) on the Fairy Prion (*Pachyptila turtur*) are statistically useful and relate body temperature to state of activity. The data of Roberts (1940) on the Wilson Petrel (*Oceanites oceanicus*) give a good indication of the ontogeny of thermoregulation in this species. The older investigations of Eydoux (1838), Martins (1856*a*, 1856*b*, 1858), Brown-Séquard (1858), and Simpson (1912) serve primarily to confirm that the body temperatures of active petrels and albatrosses in general are of the order of 38° to 41°C. Prévost (1953) has recorded the cloacal temperature of four breeding Fulmars (*Fulmarus glacialoides*) at 38.6° to 39.2°C.

PROCUREMENT OF DATA

The investigations reported in this paper were conducted on the islands of the Furneaux group in eastern Bass Strait. Most of the data were obtained at the field station of the Commonwealth Scientific and Industrial Research Organization on Fisher Island at latitude 40° 10′ S, longitude 148° 16′ E, and adjacent islets. Further data were obtained at Babel Island, latitude 39° 54′ S, longitude 148° 20′ E (Serventy, 1958:165).

Body temperature was measured by use of calibrated mercury thermometers inserted 1.5 cm. into the cloaca for one minute (Farner, 1956). To reduce thermogenic effects of excitement to a minimum, birds were captured from the surface of the ground or removed from burrows quickly and with minimum struggle. It should be noted that the birds (adults and chicks) removed from the burrows had been considerably conditioned to such manipulation by previous removals for other observations. The entire procedure from beginning of capture or removal from burrow to completion of measurement of temperature was such as to require no more than two minutes. Admittedly this type of measurement of temperature involves bias (Udvardy, 1953) which could be eliminated by the use of permanently installed thermocouples (Bartholomew and Dawson, 1954*a*); however, such a procedure was not possible in these studies. Moreover, it should be emphasized that our observations on *Puffinus tenuirostris* indicate that the "handling" bias is similar to that for *Pachyptila turtur*. This indicates that the measured temperature is in all probability within 0.2°C. of the temperature of the bird at the time capture or removal from the burrow was begun. Our experience with petrels (Farner, 1956) is somewhat different from that of Baldwin and Kendeigh (1932) with several passerine species; in these it was noted that there was frequently a decline in body temperature while the bird was held in the hand. Possibly the difference is the result of a relatively greater amount of thermogenic muscular activity in passerine birds during the process of capture with a consequent dissipation of the heat load while the bird is held quietly in the hand.

For purposes of this paper body temperature is defined as that temperature which is measured with a mercury thermometer inserted 1.5 cm. into the cloaca for one minute.

The temperatures of unoccupied burrows were measured with maximum-minimum

thermometers which were read and reset daily. The temperatures of occupied burrows were taken with an ordinary laboratory thermometer laid in the burrow while the occupant was removed temporarily for examination.

BODY TEMPERATURE OF ADULTS

The sex of many of the birds included in this study was unknown. However, a comparison of the sexes was possible on the basis of a sample of 32 birds taken from the surface of the rookeries early in the morning. The mean temperature for 15 males was 40.8°±0.25°C.; for 17 females it was 41.0°±0.17°C. Since the difference between these means is not statistically significant, we have concluded there is no important difference between the sexes and have therefore not separated them, even when possible, in our analyses.

Table 1

Cloacal Temperature in Adult *Puffinus tenuirostris* in Various States of Activity

Group	Description	No.	Mean cloacal temperature[1] °C.	Standard deviation of sample °C.
A	On surface after landing in evening	55	39.9 ± 0.13	± 0.97
B	On surface before flight in morning	37	40.9 ± 0.13	± 0.79
C	In burrow with chick	8	38.7 ± 0.20	± 0.33
D	In empty burrow	17	37.9 ± 0.09	± 0.35
E	In burrow with egg (incubating)	18	38.0 ± 0.19	± 0.83
F	In burrow feeding young	3	41.5 ± 0.41	± 0.70

[1] ± Standard error of mean.

Table 2

Comparisons of Significances of Differences Among Means

Group Mean, °C.	F 41.5	B 40.9	A 39.9	C 38.7	E 38.0	D 37.9
D	1.0 per cent	1.0 per cent	n.s.	n.s.	n.s.	
E	0.1	0.1	0.1 per cent	5.0 per cent		
C	0.1	0.1	1.0			
A	1.0	0.1				
B	n.s.					

1 per cent indicates that the means for the pair of groups indicated are significantly different at the 1 per cent level, etc.; n.s. indicates that they are not different at the 5 per cent level ($P > 0.05$) of probability.

The data on body temperatures of adults in various stages of activity have been summarized in table 1; the significances of the differences among means, as indicated by an analysis of variance, are given in table 2. Of particular interest is the mean temperature of incubating birds (38.0°±0.19°C.) which is significantly lower than that of active birds on the surface of the ground immediately after landing in the evening (Group A, 39.9°±0.13°C.) and before takeoff in the morning (Group B, 40.9°±0.13°C.), and it is also lower than that of active birds in the burrows (Group F, 41.5°±0.41°C.). This lower temperature in incubating petrels is similar to that observed by Farner (1956) in *Pachyptila turtur*, and by Folk (1949, 1951) in *Oceanodroma leucorhoa*. Thus the situation in these three species of petrels appears to differ from that of the Yellow-eyed Penguin, *Megadyptes antipodes* (Farner, 1958), in which there appears to be no difference in body temperature between incubating birds and nonincubating, nonmolting birds. Few data are available for other species. However, in the Canada Goose (*Branta*

canadensis) it appears possible that the temperature of incubating birds is lower than that of nonincubating birds (Kossack, 1947). The similarity of the means for birds (groups C, D, E) in burrows, except those feeding young, suggests that the accompanying inactivity has a temperature-depressing effect similar to that noted for *Oceanodroma leucorhoa* (Folk, 1949, 1951) and *Pachyptila turtur* (Farner, 1956) and that the lower body temperature of incubating petrels is the result of the temperature-reducing effect of burrow life rather than any peculiarity associated with incubation *per se*. Birds coming in at night to feed young are in quite a different category from adults spending a prolonged period in the burrows (such as groups C, D, and E in table 1); they remain in the burrow for comparatively short periods. It should be noted also that a similar difference in body temperature exists between chicks on the surface and chicks in the burrow (table 4). In comparison with the smaller *Pachyptila turtur* a striking difference is to be noted in *Puffinus tenuirostris* with respect to body temperature immediately after the incoming flight. In *Pachyptila turtur* the incoming birds have markedly higher temperatures than the active birds on the surface of the ground at night. This difference is lacking in *Puffinus tenuirostris*, indeed the body temperature appears to be higher in the morning before takeoff (Group B, 40.9°±0.13°C.) than after landing in the evening (Group A, 39.9°±0.013°C.). There is no apparent explanation for this difference; possibly the body temperature in flight is not as high in *Puffinus tenuirostris* as it is in *Pachyptila turtur*.

BODY TEMPERATURE AND THERMOREGULATION IN CHICKS

It is obvious (table 3 and fig. 1) that within the first day or two the chicks have sufficiently adequate thermoregulation to maintain essentially adult temperatures in the burrow environment of about 22°C. (fig. 2), an environment whose maximum daily fluctuation in temperature is less than 5°C. Although the improvement in thermoregulation and the increase in body temperature after hatching appear to be rather slight, an analysis of variance of cloacal temperature of 15 chicks for the first 6 days after hatching reveals that individual chicks tend to have their own characteristic body tem-

Table 3

Cloacal Temperature in *Puffinus tenuirostris* Chicks in Relation to Age and Burrow Temperature. Data for Selected Intervals

	Adult present			Adult absent			Difference between chick and burrow temperature		
Day of Life	No.[1]	Mean cloacal temperature[2] °C.	Standard deviation of sample °C.	No.	Mean cloacal temperature[1] °C.	Standard deviation of sample °C.	No.	Mean difference[1] °C.	Standard deviation of sample °C.
1	14	37.9 ± 0.12	± 0.36	1	37.7	....	15	14.6 ± 0.48	± 1.86
2	10	38.2 ± 0.22	± 0.70	5	38.4 ± 0.27	± 0.61	15	15.1 ± 0.49	± 1.89
3	5	38.8 ± 0.33	± 0.74	10	38.3 ± 0.09	± 0.30	15	16.3 ± 0.48	± 1.85
4	4	38.5 ± 0.22	± 0.41	11	38.7 ± 0.13	± 0.41	....	....	....
5	2	38.4 ± 0.15	± 0.21	13	38.4 ± 0.17	± 0.65	15	17.2 ± 0.31	± 1.20
6	1	38.9	....	14	38.3 ± 0.22	± 0.82	....	....	....
7	2	39.0 ± 0.20	± 0.28	12	38.4 ± 0.16	± 0.56	....	....	....
10	....	....	....	6	38.3 ± 0.28	± 0.68	6	16.5 ± 0.30	± 0.75
33–45	....	....	....	17	38.6 ± 0.08	± 0.33	17	19.9 ± 0.33	± 1.35
88–98	....	....	....	17	38.4 ± 0.15	± 0.63	17	21.4 ± 0.18	± 0.75

[1] The data for days 1 through 10 all are from the same group of 15 chicks. The data for 33–45 and 88–98 days are from another group of 17 chicks.
[2] ± Standard error of the mean.

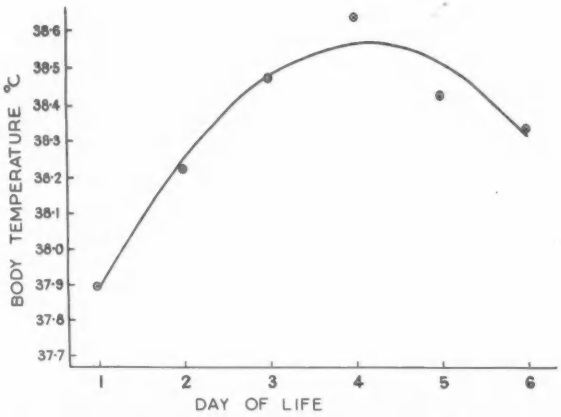


Fig. 1. Body temperature in *Puffinus tenuirostris* during the first six days after hatching. The plotted points are means for 15 chicks. See text for calculation of curve.

perature and, more importantly, that the increase in body temperature from day 1 to day 4 is very significant ($P<0.01$). A quadratic regression of cloacal temperature (y) on days (x) accounted for practically all the variability between day means, both regression coefficients being highly significant ($P<0.001$) and the residual on 3 degrees of freedom being negligible and not significant. The curve relating body temperature as a function of time after hatching may be represented by:

$$y = 38.538 + 0.0867\ x - 0.0698x^2$$

where x is the day of life $- 3.5$, and y is body temperature. Equating the differential of this equation to zero indicates that the maximum temperature (about 38.6°C.) is attained during the fourth day. The subsequent history of body temperature of chicks after the sixth day does not lend itself to useful analysis with the data available. Apparently it is one of a slight and uneven downward trend toward the typical body temperatures of quiet adults in burrows. On the basis of information available, we cannot offer a suggestion of the biological significance of the surpassing of the adult levels beginning about the second day of life.

Unfortunately there are no comparable series of data for other species of petrels. The limited series of observations by Roberts (1940) on the chicks of *Oceanites oceanicus* lead him to the conclusion that they pass through a semi-poikilothermal stage, since, at the ages of one and two days the body temperature is 30°C. or less; between the fourth and seventh days it apparently stabilizes at 36.5° to 37.5°C. where it remains at least until the 40th day. Although comparisons must be made cautiously, it would appear then that in both *Puffinus tenuirostris* and *Oceanites oceanicus* there is an improvement in thermoregulation and an increase in body temperature during the first few days after hatching. The increase in body temperature is rather slight in *Puffinus tenuirostris* whose burrows have a mean temperature of about 22°C. whereas it is quite pronounced in *Oceanites oceanicus* where the mean temperature of the burrows is of the order of 0° to 5°C. Because of this difference in burrow temperatures, it should not be assumed by any means that the thermoregulatory ability of the chicks of *Puffinus tenuirostris* is necessarily superior to that of the chicks of *Oceanites oceanicus*. Our observations suggest

that the early development of adult body temperatures in *Puffinus* represents an adaptation which permits the chicks to be left unattended in a relatively cool environment. Ordinarily the chick is attended by the parents only for two days after hatching, but it may be alone in the burrow even on the first day (table 3). The same adaptation may well exist in *Oceanites oceanicus* except that it does not compensate completely for the much lower burrow temperatures. The ability of the chicks of *Puffinus tenuirostris* to maintain an essentially adult body temperature in an environment 15° lower is quite remarkable.

It is of interest to compare the thermoregulatory ability of the chicks of *Puffinus tenuirostris* with those of other precocial species. It appears that it is quite comparable with that of the chicks of the Common Eider (*Somateria mollissima*) in which thermoregulation becomes well established at 2 to 7 hours after hatching (Rolnik, 1948). Ap-

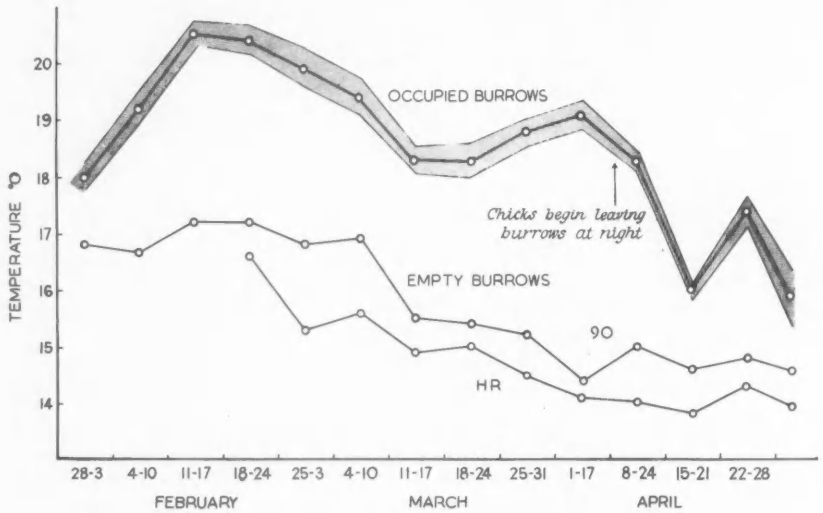


Fig. 2. Temperatures in the burrows of *Puffinus tenuirostris* during the breeding season. Plotted points for occupied burrows are weekly means for about 20 burrows. Shaded area includes ± 2 standard errors of the mean. Plotted points for empty burrows are weekly means for single burrows.

parently thermoregulation develops earlier in *Puffinus tenuirostris* than in the chicks of such galliform species as the domestic fowl (Randall, 1943), the quail, *Coturnix coturnix* (Böni, 1942), and the Ring-necked Pheasant, *Phasianus colchicus* (Ryser and Morrison, 1954). According to the excellent series of observations by Barth (1951) the chicks of the Mew Gull (*Larus canus*), the Herring Gull (*Larus argentatus*), the Lesser Black-backed Gull (*Larus fuscus*), and the Great Black-backed Gull (*Larus marinus*) develop fairly good thermoregulation by the end of the first day and after three days can maintain near-adult thermoregulation except under very severe conditions. This is consistent with the observations of Rolnik (*op. cit.*) who concluded that thermoregulation is well established between the second and third day after hatching in *Larus canus* and between one and one-half and two days in *Larus argentatus*. The observations of Bar-

tholomew and Dawson (1952, 1954*b*) indicate an approximately similar ontogeny of thermoregulation in the Western Gull (*Larus occidentalis*). On the other hand good thermoregulation does not develop in the chicks of the Black-legged Kittiwake (*Rissa tridactyla*) until the sixth or seventh day (Rolnik, *op. cit.*). Rolnik (*op. cit.*) also found that the development of thermoregulation in certain alcids was similar, or perhaps slightly slower, than in *Larus*. Her observations indicate adequate development at about three days in the Common Murre (*Uria aalge*), three to four days in the Razorbill (*Alca torda*), three to four days in the Black Guillemot (*Cepphus grylle*), and six to seven days in the Common Puffin (*Fratercula arctica*). Since the chicks of most of these alcid and larid species are naturally subjected to greater extremes of environmental conditions than those of *Puffinus tenuirostris*, a precise physiologic comparison of their thermoregulatory abilities is not possible without comparably controlled experiments. Related to their own environments, however, there appears to be no doubt that an adequate thermoregulation develops earlier in *Puffinus tenuirostris* than in the gulls and alcids.

Our data for older chicks in the burrows (table 3, 33–45 and 88–98 days) indicate a close similarity with those of Folk (1951) for *Oceanodroma leucorhoa*; nine young birds aged 45 to 65 days had body temperatures ranging from 38.2° to 39.7°C.; a tenth was recorded at 35.0°C. The temperature of the burrows of this species is about 12°C.

BURROW TEMPERATURES

The burrow provides a relatively stable micro-climate. Whereas mean daily air temperatures (in shade) oscillate between 15° and 30°C., the diurnal range in unoccupied burrows is only of the order of 1° to 5°C. (Serventy, 1958). In the occupied burrows the presence of the birds has a warming and stabilizing effect on the temperature (fig. 2).

Table 4

Cloacal Temperatures of Chicks of *Puffinus tenuirostris* for the First Six Days after Hatching
Analysis of Variance

Source	Degrees of freedom	Sum of squares	Mean square	Variance ratio
Individual chicks	14	9.1582	0.6542	2.37[1]
Days	5	4.9125	0.9825	3.56[1]
Chicks x days	70	19.3325	0.2762	
Total	89	33.4032		

[1] Highly significant ($P < 0.01$).

Table 5

Cloacal Temperature in Fully Grown Chicks of *Puffinus tenuirostris*
Comparison of Birds in Burrows with Birds on Surface

Group	Description	No.	Mean cloacal temperature[1] °C.	Standard deviation of sample °C.
C–1	Chicks, 97–106 days old, in burrows	7	38.4 ± 0.41[2]	± 1.16
	Same individuals on surface, same day	7	39.7 ± 0.35[2]	± 0.69
C–2	Chicks, 88–98 days old, in burrows	17	38.4 ± 0.15[3]	± 0.63
C–3	Chicks, 96–106 days old, on surface	53	39.7 ± 0.13[3]	± 0.92

[1] ± Standard error of mean.
[2] Significantly different at 5 per cent level.
[3] Significantly different at 0.1 per cent level.

In both the occupied and unoccupied burrows a maximum level of summer temperature is attained during the latter part of February; thereafter there is a slow decline which is arrested and reversed in the occupied burrows during March and early April by the warming effect of the large rapidly growing chick. The seasonal decline is resumed in late April when the chicks begin to spend a large portion of the night outside of the burrow.

ACKNOWLEDGMENTS

A portion of the data on which this paper is based was obtained while one of us (Farner) was a Fulbright Research Scholar at the University of Otago, New Zealand. The necessary visit to Fisher Island was made possible by support from the United States Educational Foundation in New Zealand and the United States Educational Foundation in Australia. The analyses and preparation of the manuscript were effected subsequently while he was a Guggenheim Fellow at the University of Western Australia and the Western Regional Laboratory of the Commonwealth Scientific and Industrial Research Organization, Nedlands, Western Australia.

The authors wish to express their sincere appreciation to Mr. N. S. Stenhouse and Mr. Clive Boundy of the Division of Mathematical Statistics at the Western Regional Laboratory of the Commonwealth Scientific and Industrial Research Organization for advice and assistance in the statistical analyses. Mr. G. M. Storr performed some of the analyses of the data on burrow temperatures and prepared figures 1 and 2. We are also indebted to Dr. R. Mykytowycz, pathologist of the Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization, for his kindness in measuring the temperatures of a series of newly hatched chicks, and to Mr. V. N. Serventy for assistance in obtaining other data on body temperatures.

SUMMARY

The body temperature of adult Slender-billed Shearwaters (*Puffinus tenuirostris*) on the surface of the ground in the nesting colonies is from 40° to 41°C. It is apparently higher in the morning before takeoff (40.9°±0.13°C.) than in the evening after landing (39.9°±0.13°C.). Adults in the burrows, except when feeding chicks, have lower temperatures; in incubating birds and in those in empty burrows the body temperature is about 38°C. The lower temperature of the incubating birds should be regarded as characteristic of quiet burrow life rather than as a functional peculiarity of incubation itself.

The chicks of *Puffinus tenuirostris* at hatching, or within a very few hours thereafter, have sufficient thermoregulatory capacity to maintain adult body temperatures in burrows at temperatures of about 22°C. There is a slight, although very significant, increase in body temperature during the first four days after hatching. Older chicks have a higher temperature on the surface of the ground than in the burrows. The difference is similar to that of the adults.

DEDICATION

This paper is dedicated to Professor Erwin Stresemann on his 70th birthday anniversary.

LITERATURE CITED

Baldwin, S. P., and Kendeigh, S. C.

1932. Physiology of the temperature of birds. Sci. Publ. Cleveland Mus. Nat. Hist., 3. 196 pp.

Barth, E. K.

1951. Kroppstemperatur hos måkeunger. Nytt Magasin for Naturvidenskapene, 88:213–245.

Bartholomew, G. A., and Dawson, W. R.
1952. Body temperatures in nestling western gulls. Condor, 54:58–60.
1954*a*. Body temperature and water requirements in the mourning dove, *Zenaidura macroura marginella*. Ecology, 35:181–187.
1954*b*. Temperature regulation in young pelicans, herons, and gulls. Ecology, 35:465–472.
Böni, A.
1942. Ueber die Entwicklung der Temperatur-regulation bei verschiedenen Nesthockern (Wellensittich, Neuntöter und Wendehals). Arch. suisses Ornithol., 2:1–56.
Brown-Séquard, E.
1858. Sur la basse température de quelques palmipèdes longipennes. Jour. de Physiol. de l'homme et des animaux, 1:42–46.
Eydoux, F.
1838. Sur la température de l'homme et des oiseaux. C. R. Acad. Sci. Paris, 6:456–458.
Farner, D. S.
1956. Body temperature of the fairy prion (*Pachyptila turtur*) in flight and at rest. Jour. Appl. Physiol., 8:546–548.
1958. Incubation and body temperatures in the yellow-eyed penguin. Auk, 75:249–262.
Folk, G. E.
1949. Body temperature of Leach's petrel. Anat. Rec., 105:590.
1951. Observations on the body temperature of Leach's petrel. Anat. Rec., 111:541–542.
Kossack, C. W.
1947. Incubation temperatures of Canada geese. Jour. Wildlife Manag., 11:119–126.
Martins, C. F.
1856*a*. Sur la température moyenne des oiseaux palmipèdes du nord de l'Europe. C. R. Acad. Sci. Paris, 42:515–518.
1856*b*. Mémoire sur le température des oiseaux palmipèdes du nord de l'Europe. Mém. Acad. Sci. Lett. Montpellier, 39:189–223.
1858. Mémoire sur la température des oiseaux palmipèdes du nord de l'Europe. Jour. de Physiol. de l'homme et des animaux, 1:10–41.
Prévost, J.
1953. Notes sur la reproduction du Fulmar antarctique, *Fulmarus glacialoides* (A. Smith). Alauda, 21:157–164.
Randall, W. C.
1943. Factors influencing the temperature regulation of birds. Amer. Jour. Physiol., 139:56–63.
Roberts, B.
1940. The life cycle of Wilson's petrel, *Oceanites oceanicus* (Kuhl). British Graham Land Expedition 1934–1937. Sci. Rep., 1:141–194.
Rolnik, V. V.
1948. Razvitiye termoryegulyatsii u nyekorikh ptits syevyera. Zool. Zhur., 27:535–546.
Ryser, F. A., and Morrison, P. R.
1954. Cold resistance in the young ring-necked pheasant. Auk, 71:253–266.
Serventy, D. L.
1958. General description of Fisher Island and its mutton-bird rookeries. Papers and Proceedings Roy. Soc. Tasmania, 92:165–170.
Simpson, S.
1912. Observations on the body temperatures of some diving and swimming birds. Proc. Roy. Soc. Edinburgh, 32:19–35.
Udvardy, M. D. F.
1953. Contributions to the knowledge of the body temperature of birds. Zool. Bidrag Uppsala, 30:25–42.

Laboratories of Zoophysiology, Department of Zoology, Washington State University, Pullman, Washington, and Wildlife Survey Section, Commonwealth Scientific and Industrial Research Organization, University Grounds, Nedlands, Western Australia, March 23, 1959.

FROM FIELD AND STUDY

Cliff Swallows of Mixed Plumage Types in a Colony in Southeastern Arizona.—The A.O.U. Check-list (1957:364) outlines the breeding ranges of two races of the Cliff Swallow (*Petrochelidon pyrrhonota*) as follows: *P. p. tachina* "from the lower Colorado River Valley and northern Arizona (Tuba City, Lakeside, Springerville), and central New Mexico, to southern Texas"; *P. p. minima* "from southeastern Arizona (San Bernardino Ranch, St. David, Sonoita), eastern Sonora, and western Chihuahua south . . . ." Brandt (Arizona and Its Bird Life, 1951:668) found four colonies of *minima* in southeastern Arizona and says of one of these: "a colony of perhaps 30 pairs built under the high modern steel bridge over the San Pedro River, 5 miles south of Benson, until almost stoned out by boys."

On a field trip to southeastern Arizona in 1959, I visited five bridges which cross the San Pedro River, including the one mentioned by Brandt, which is just west of St. David. The sites and dates visited, listed from north to south, were: St. David (May 30), Fairbank (May 30 and June 5), Lewis Springs (State Highway 90, May 31), Hereford (June 5), and State Highway 92 (June 5). The only one of these locations at which Cliff Swallows were present was Fairbank, where at least 30 pairs were nearing the end of nest construction.

Van Tyne and Sutton (Misc. Publ. Mus. Zool. Univ. Mich., 37, 1937:58, 59) record the presence of *melanogaster* (= *minima*) in Brewster County, Texas, and state: "All of these specimens were breeding birds collected from nesting colonies, and their presence in breeding colonies of *tachina* is hard to explain if *tachina* and *melanogaster* are indeed geographical races of one species, as is commonly accepted." Van Rossem (Occ. Papers Mus. Zool. La. State Univ., 21, 1945:166) states that he is "far from convinced that the common and Mexican Cliff Swallows are conspecific."

The majority of the individuals which I saw at the Fairbank colony had the dark foreheads characteristic of *minima*, but a surprising proportion had the light foreheads to be expected in more northern populations. Although there may have been some slight variation in the color of the light foreheads, I saw no birds which could not be clearly assigned to "dark" or "light" classification. On May 30 I selected a group of six nests to determine if there were mixed pairs with regard to forehead color. The same nests were briefly checked again on June 5. The results were:

	May 30	June 5
Nest 1	2 dark	none entered
Nest 2	1 dark, 1 light	1 dark, 1 light
Nest 3	1 dark	1 dark
Nest 4	2 dark	1 dark
Nest 5	1 dark, 1 light	1 dark
Nest 6	none entered	2 light

Nest 4 was only a shelf on May 30 but was substantially completed on June 5. On May 30 in Nest 5 I observed what may have been copulation, but the two birds may have been merely jockeying for more comfortable positions near the entrance. I never saw more than one bird at a time in Nest 3; very likely both members of the pair at this nest had dark foreheads.

The evidence from this group of nests suggests that the proportion of dark to light foreheads on birds at this colony is about 2:1 and that the birds mate without regard to forehead color.—HORACE H. JETER, *Shreveport, Louisiana, July 7, 1959.*

The Barrow Goldeneye in Texas.—Recently Mr. Tom Cole, a resident of Greenville, Hunt County, Texas, brought to me for examination a mounted specimen of an adult male Barrow Goldeneye (*Bucephala islandica*). Mr. Cole had shot the specimen on a stock tank just southwest of Greenville on November 6, 1958. As far as I have been able to ascertain, this constitutes the only specimen-supported record of the Barrow Goldeneye in Texas.—F. W. MILLER, *Dallas Museum of Natural History, Dallas, Texas, April 22, 1959.*

Gila Woodpecker in San Diego County, California.—During midday on October 17, 1952, I was driving on a seldom used side road in the mountains near Jacumba, 70 miles east of San Diego, California, at an altitude of 2800 feet, when I heard a whining squeal which I recognized as the voice of a Gila Woodpecker (*Centurus uropygialis*). Somewhat surprised to hear that familiar high-pitched nasal call in such Upper Sonoran surroundings I stopped the car and located the bird a short distance ahead on a 20-foot pole. The woodpecker sidled around the pole, appearing on both sides and on top, ducking and bowing its head and noisily calling in habitual fashion as I advanced afoot. After close and detailed observation I flushed the woodpecker from the pole and clearly saw the characteristic white wing patches.

Some years later in a casual conversation with Mr. Laurence Huey and Mr. James Sams of the San Diego Museum of Natural History, I mentioned this observation of which I had made written notation and was much surprised to learn that no specimen of a Gila Woodpecker had ever been collected in San Diego County nor was there on record any sight identification. That a Gila Woodpecker should never before have been sighted in the mountains along the extreme eastern boundary of San Diego County seems strange.

Gila Woodpeckers frequent regions on two sides of Jacumba: to the east in Imperial Valley scarcely 50 air miles distant, and to the south not more than 60 air miles away in the rugged, isolated palm canyons that cut the precipitous east face of the Sierra Juárez of Baja California. I have found them common there at altitudes up to 2000 feet. The mountain chain on which Jacumba is situated is nothing more than a northward extension of the Sierra Juárez. It would be no great aerial feat for Gila Woodpeckers to wander northward to Jacumba or beyond following this cordillera. The altitude of Jacumba would be no bar to the Gila Woodpecker. Bent (Bull. U. S. Nat. Mus. No. 174:250–256) states that it ranges up to 4000 or even 4500 feet in the canyons and foothills of its normal habitat, adding that this woodpecker seems somewhat given to wandering in fall and spring, reaching to such higher altitudes.—LEON L. GARDNER, *Department of Public Health, San Diego, California, March 20, 1959.*

Black-throated Sparrows in Northwestern Oregon.—On May 16, 1959, Fred Crenshaw informed me that he had taken a Black-throated Sparrow (*Amphispiza bilineata*) at his banding station near Beaverton, Oregon. Mr. Crenshaw's description of the bird in hand left no doubt that his identification was correct.

A little later, on May 28, Mrs. John Dobak reported that two Black-throated Sparrows were in her yard near Milwaukie, Oregon. Arriving there a few minutes later, I was able to observe one of the birds at a distance of about twenty-five feet and confirm her identification. I am familiar with the species, having observed them often in Arizona and Texas.

On June 4 I was advised that Mrs. Ernest H. Baker, of Depoe Bay, on the Oregon coast, had had one of these sparrows at her home for two days. Her description was definite.

The only previous records of the species in Oregon are from the desert in Harney County, in the southeastern part of the state. Two specimens were taken on Wright's Point, June 24 and 25, 1908, by William L. Finley and Herman T. Bohlman, and one was taken by Stanley G. Jewett on July 15, 1912, at Silver Lake.

It is of interest that these desert birds appeared almost simultaneously in three separate regions in the humid section of northwestern Oregon.—H. M. DU BOIS, *Clackamas, Oregon, June 6, 1959.*

A Third Head-scratching Method of Emberizine Sparrows.—Heinroth (Aus dem Leben der Vogel, 1938) and Nice (Trans. Linn. Soc. N. Y., 6, 1943:1–328) made early observations on differences in the way that birds scratch their heads. Recently, Simmons (Ibis, 1957:178–181) reviewed this behavior trait and concluded that two methods are used: "direct" in which the leg is brought directly to the head, and "indirect" in which the leg is brought over the drooped wing. He also concluded that only one of these two methods is used by all the species of a given family. Thus it appeared that this behavior trait would be quite useful as a taxonomic character on the family level, and it has been so used (Simmons, *op. cit.*; Brown, Condor, 61, 1959:53).

Observations of wild and captive birds do not completely bear out Simmons' second conclusion. Nice (*op. cit.*:45) found one species of the Parulidae that scratched directly, and Ficken and Ficken (Ibis, 1958:277–278) found two more members of the same genus which scratched directly as young

but later switched to the indirect method. The Fickens also noted several other species which scratch directly in the nest but later change. Finally, different adults of the same species were reported to scratch in different ways (Nice and Schantz, Ibis, 1959:250–251, Auk, in press) and one fledged individual was seen to scratch both ways (Hailman, Ibis, 1959, in press). In addition, Conway (Anim. Kingdom, 60, 1957:182–186) may have observed direct scratching in a Rose-breasted Grosbeak (*Pheucticus ludovicianus*), which usually scratches indirectly (Ficken and Ficken, *op. cit.*), and I once thought one of my captive Fox Sparrows (*Passerella iliaca*) scratched directly, although the same bird repeatedly scratched indirectly. In addition, recent experiments on head-scratching behavior (Nice and Schantz, *op. cit.*) show an even greater variability between individuals of the same species and in individual birds. The method of scratching is, therefore, not really specific to a family or genus, and even a species or an individual in some cases may show variation.

Exceptions to Simmons' first conclusion have also been noted. For instance, Dilger saw a young Starling (*Sturnus vulgaris*) scratch with its right wrist (Ficken and Ficken, *op. cit.*), and Andrew (Brit. Jour. Anim. Behav., 4, 1956:85–91) relates that captive European buntings (*Emberiza* sp.) sometimes rub their heads against their perches.

In the winter and spring of 1958 I made extensive observations on maintenance activities such as preening and head-scratching in several North American emberizine sparrows. With the exception of the Fox Sparrow mentioned earlier, all the species I observed scratched exclusively by the indirect method when the leg was used. Since observations of others bear this out, it is now fairly well established that the normal emberizine method is indirect. Several of my emberizines also employed perch-scratching movements apparently similar to those described by Andrew. The motions, described below, now appear to be widespread enough, at least in the Emberizinae, to justify considering them a "third" method of head-scratching, to be added to the direct and indirect methods.

Emberizine perch-scratching behavior appears to be directed to the side of the head and does not seem to be given in response to any evident external stimuli. The motions resemble those of bill-wiping in that the head is lowered to the perch, but perch-scratching is a slower, rolling movement of the head against the limb, as opposed to the rapid stropping motions of bill-wiping. Perch-scratching motions are variable in form, and possibly are primarily the result of individual experience, in contrast to the more rigid direct and indirect scratching motions. Since emberizines sometimes performed perch-scratching closely following indirect scratching, it seems likely that indirect and perch-scratching behavior may be similarly motivated in sparrows. The species which I observed perch-scratching are: Slate-colored Junco (*Junco hyemalis*), Tree Sparrow (*Spizella arborea*), Song Sparrow (*Melospiza melodia*), and Fox Sparrow.

I have since observed an apparently similar action in the Mockingbird. During the fall and winter of 1959 I observed a color-banded individual in Norfolk, Virginia. At the time of banding, the bird had several cyst-like growths, perhaps sucking parasites, on either side of its face. For the two months I watched this bird on winter territory, it attempted repeatedly to scratch these growths from its head. In doing so, it used neither the direct nor indirect methods, but instead rubbed the side of its head against the tree limb on which it was perched. In general form the motion was somewhat similar to the emberizine perch-scratching behavior, except that the Mockingbird's movements were much less stereotyped and were directed at the parasites rather than the side of the head. The bird would lower its head so that the area of the parasites was against the limb and then attempt to scratch them off with both lateral and vertical movements. As far as I know, the behavior was ineffective in removing the growths.

During the same study period, I observed the Mockingbird scratch its head indirectly several times, and I never saw the feet touch the facial growths. Rather, the indirect scratching seemed to be concentrated on an area behind and slightly below the eye, a region never touched during the rubbing.

The perch-scratching and indirect-scratching of emberizines seem to be performed together and directed to the same general areas of the head, suggesting that the former is elicited and directed by the same stimuli and has the same biological function as the latter. In contrast are the similar rubbing movements of the color-banded Mockingbird. It is somewhat puzzling that the bird did not try to scratch the growths by the normal indirect method. Perhaps the "scratch-reflex" is just too rigid to be adaptable to removing the growths. At any rate, since the indirect scratching and the rubbing motions involved different areas of the bird's head, and were not performed in close sequence, it seems likely

that different releasing and directing stimuli are controlling these motions and that they therefore differ in biological function.

The observations of perch-scratching in emberizines further complicates our understanding of the distribution of head-scratching methods among birds, for now three, instead of two, variables must be investigated. Perhaps perch-scratching does not occur outside the Emberizinae, in which case it becomes a special instead of a general problem. Are these three scratching methods exactly equivalent, or does a different complex of stimuli release and direct each type? It is not within the scope of this paper to consider fully the biological function and motivation of head-scratching motions, but I suggest that this will need to be done before a complete understanding of the distribution of motions can be gained.

Because perch-scratching has added new problems and because a much higher variability than first expected (Simmons, *op. cit.*) has been found in the method of head-scratching used, taxonomic conclusions based on the type of scratching utilized should be considered tentative until all such behavior is better understood.

My sincere thanks go to Mrs. Margaret Nice for her many suggestions concerning the manuscript of this article and about the subject of head-scratching.—Jack P. Hailman, *Bethesda, Maryland, June 23, 1959.*

Some Additional Records of the Skua from California.—Prior to 1944 there were but four specimens and a single sight observation of the Skua (*Catharacta skua*) for California (Grinnell and Miller, Pac. Coast Avif. No. 27, 1944:160). Between 1944 and 1959 there have been more observations of this species off California than the total to 1944. In view of the comparative rarity of this bird and the vagaries of its appearances here, it might be well to outline some of the known records since the publication of Avifauna No. 27. Increased interest by amateur and professional ornithologists in searching for and observing pelagic birds has probably accounted in part for some of the following records. However, some years (1945, 1947–50, 1952–53, 1955) passed without any observations of this species although numerous pelagic trips were made in the late summer and early fall of these years. Notable flight years were 1956 and 1957, the latter being nothing short of remarkable. Some explanation might be found in examination of oceanographic conditions in late 1956 and in 1957. The year of 1957 was known as the year of warm water and southern fish, during which ocean temperatures were raised 2°F. to 5.5°F. along the Pacific coast from Crescent City, California, to Baja California and some tropical species of fish were taken off the coast of Washington.

A single Skua was observed at Santa Monica Beach on February 10 and 20, 1946, by Alma Stultz, Alan Morgan, and others (Pyle, Annotated Field List of the Birds of Southern California, 1953:23); another was seen at almost the identical place on April 4, 1951, by Lasky (Condor, 54, 1952:175); one specimen was collected (the fifth from California waters) on October 3, 1954, by Howard Cogswell several miles northeast of southeast Farallon Island (Audubon Field Notes, 9, 1955:52); a single bird was seen in the San Pedro Channel on March 21, 1955, by Vivian Ross and Ruth P. Emery (Audubon Field Notes, 9, 1955:284); two were seen on September 29, 1956, by Dean B. Fisher, 27 miles southwest of Point Conception (MS); at least eight were seen (some within 20 feet) on September 30, 1956, by Dean B. Fisher in the area from 5 miles northwest to 3 miles south of southeast Farallon Island (Audubon Field Notes, 11, 1957:55); one was seen 6 miles southeast of Pyramid Cove, southeast end of San Clemente Island on August 13, 1957, by me and one was seen on August 29, 1957, by John Bishop south of the southeast end of San Clemente Island (Audubon Field Notes, 11, 1957:428); one was seen on September 22, 1957, by some members of the Los Angeles Audubon Society southwest of Santa Cruz Island (Audubon Field Notes, 11, 1957:429); at least six (with a total of ten separate sightings, including three in view at once and photographed sitting on the water) were seen on October 5, 1957, by me at points from 7 to 12 miles west of Monterey; and one bird was seen on October 4, 1958, northeast of Catalina Island by G. S. Suffel (MS).—Arnold Small, *Los Angeles, California, February 11, 1959.*

Another Record of the Orchard Oriole in California.—Several times in the month of March, 1958, a black and chestnut-colored oriole was seen in a large rattlebox shrub (*Crotalaria capensis*) which is in my yard in San Diego, California. The bird was taking nectar from the canary-colored

flowers in characteristic oriole fashion. The color and markings agree with those of the Orchard Oriole (*Icterus spurius*) which has been recorded only once before in California at Eureka (Davis, Condor, 35, 1933:119). One brief visit of the oriole on March 30, 1958, was recorded on fourteen feet of 16mm. motion picture color film. James E. Crouch of San Diego State College confirmed the identification on viewing this film.—Myrtle E. Johnson, *San Diego, California, February 15, 1959.*

Occurrences of the Mockingbird at the Northwestern Margin of Its Range.—Vagrant Mockingbirds (*Mimus polyglottos*) have been recorded heretofore in northwestern California north to Ferndale, Humboldt County, where one was seen repeatedly in 1922 (Grinnell and Miller, Pac. Coast Avif. No. 27, 1944:345). Recently I have detected the species twice at points farther north in this area. On March 14, 1957, one appeared with a flock of Cedar Waxwings (*Bombycilla cedrorum*) in Eureka, Humboldt County. At Gold Beach, about 5 miles north of Orick in this county, one was seen and heard singing on May 26, 1959.—Ken Legg, *Eureka, California, January 26, 1959.*

Changes in Winter Bird Species Composition of Two Habitats in San Miguel County, New Mexico, After Three-fourths of a Century.—Seventy-six years ago Charles F. Batchelder (Auk, 2, 1885:121–128, 233–239) spent December 4 to 22, 1882, collecting bird specimens and describing habitats frequented by the various species in the vicinity of Las Vegas Hot Springs, San Miguel County, New Mexico. In December of 1958 observations were made by me on the bird species composition in two of these same habitats and the results are here compared with those obtained by Batchelder.

One site is occupied by an open stand of ponderosa pine (*Pinus ponderosa*) situated on a steep south-facing canyon slope 1.3 road miles above the junction of the effluent of the hot springs and the Gallinas River. The understory vegetation here consists primarily of a sparse representation of scrub oaks (*Quercus* sp.) and blue grama grass (*Bouteloua gracilis*). The second habitat consists of streamside vegetation downstream from the canyon mouth for a distance of about one mile. The vegetation consists largely of a narrow corridor of tall cottonwoods (*Populus angustifolia* and *P. wislizeni*) with an understory of shrub willows (*Salix* sp.). A series of alfalfa fields borders the cottonwoods. A few abandoned fields and fence rows support variable stands of weedy annuals of which the sunflower (*Helianthus annuus*) is most conspicuous.

Five visits were made to each habitat between 8:00 a.m. and noon in the period from December 6 to 28.

For the most part the birds most frequently observed are those also recorded by Batchelder. Gray-headed Juncos (*Junco caniceps*) and Pine Siskins (*Spinus pinus*) are the most abundant birds of this season. The Pygmy Nuthatch (*Sitta pygmaea*), Steller Jay (*Cyanocitta stelleri*), Brown Creeper (*Certhia familiaris*), and Townsend Solitaire (*Myadestes townsendi*) are characteristic birds of the pine habitat and there appear to have been no important changes in the winter bird species composition in the habitat since 1882.

The species characteristic of the cottonwood habitat at the present time are the Black-billed Magpie (*Pica pica*), Common Crow (*Corvus brachyrhynchos*), Song Sparrow (*Melospiza melodia*), Spotted Towhee (*Pipilo erythrophthalmus*), and Downy Woodpecker (*Dendrocopos pubescens*). Magpies and crows apparently are new additions to the habitat while no individuals of the Water Ouzel (*Cinclus mexicanus*) and Green-winged Teal (*Anas carolinensis*), both reported as being common by Batchelder, were observed at any time. The changes that have occurred in species composition are probably related to agricultural practices. The absence of the Green-winged Teal and the Water Ouzel is believed to be related to changes in stream environment resulting from diversion of stream flow for irrigation storage purposes. A diversion dam, established about forty years ago, near the canyon mouth presently allows only a meager water flow along the original stream bed. No pools remain which might attract waterfowl and the reduced current apparently does not provide an environment attractive to the Water Ouzel.

The occurrence of magpies and crows cannot be attributed to any great alteration in physical environment since the gross vegetation mosaic is similar to that of 1882. It seems likely that changes in land usage have contributed to the appearance of these species.—W. H. Rickard, *New Mexico Highlands University, Las Vegas, New Mexico, June 1, 1959.*

NOTES AND NEWS

The annual meeting of the Cooper Ornithological Society will be held in Los Angeles in 1960. Scientific sessions on April 29 and 30 will be at the Los Angeles County Museum and the University of California, Los Angeles, respectively. Aviary and art exhibits and a reception are scheduled for April 28 and a field trip on May 1.

Part II of Skutch's Life Histories of Central American Birds, illustrated by Don R. Eckelberry, is now in late proof stages. This book, published as Pacific Coast Avifauna No. 34, will be available in about two months and Cooper Society members will soon have opportunity to place their orders for it.

Speakers and their subjects at recent divisional meetings of the Cooper Society included E. M. Nicholson, Executive Director of the Nature Conservancy of England, on "Nature Conservation in Britain," at Berkeley on May 13, and Robert L. Rudd of the Department of Zoology, University of California, Davis, on "Nature and Poisons —a Zoologist's View," at Berkeley, on October 1.

Applications are invited for Director of the newly-founded Percy Fitzpatrick Institute of African Ornithology at the University of Cape Town. The Institute is an independent organization, but the post carries academic status and membership in the University Institutions Provident Fund, which is compulsory. Applicants should have an M.Sc. or its equivalent, preferably in zoology, and have experience in organized research.

Duties include organization and conduct of ornithological research, administration of the Institute's affairs under a board of control, and responsibility for the proper housing and cataloguing of ornithological records and library.

Applications accompanied by not less than two recent testimonials, giving age, marital status, and providing details of qualifications as well as of previous experience must be received before February 1, 1960.—C. K. Niven, *Chairman, Board of Control, Amanzi, Uitenhage, Cape Province, South Africa.*

The National Science Foundation announces that final proposals for antarctic research for the 1960–61 field season should be submitted by February 15, 1960, in order to allow the necessary time for scientific review and field planning. Proposals should be addressed to the Director, National Science Foundation, Washington 25, D.C., attention of Antarctic Program Director. The staff of the Antarctic Research Program of the NSF will be happy to discuss ideas for proposals informally prior to their final submission or to answer questions regarding the preparation of proposals and problems of research in the antarctic.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the life sciences is January 15, 1960. Proposals received prior to that date will be reviewed at the spring meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after January 15, 1960, will be reviewed following the summer closing date of May 15, 1960.

MINUTES OF DIRECTORS' MEETING

Pursuant to the By-Laws, the Board of Directors of the Cooper Ornithological Society held an organizational meeting following the election of the Directors at the annual meeting of the members of the corporation. Said Board meeting was held at 5:00 p.m., on April 4, 1959, in 2503 Life Sciences Building, University of California, Berkeley, California.

J. R. Pemberton presided. Other members present were: John Davis, Thomas R. Howell, Alden H. Miller, Frank A. Pitelka, and Jack C. von Bloeker, Jr.

It was moved that the reading of the minutes of the meeting of April 26, 1958, be dispensed with. The motion was seconded and carried unanimously.

It was moved that the following slate of officers of the Corporation be elected to serve for the ensuing year:

President—J. R. Pemberton
Sr. Vice-President—W. J. Sheffler
Jr. Vice-President—Frank A. Pitelka
Secretary—John Davis
Assistant Secretary—Thomas R. Howell.
Endowment Secretary—C. V. Duff
Treasurer—Jack C. von Bloeker, Jr.
Business Manager—C. V. Duff

Assistant Business Managers—Ed N. Harrison and Thomas R. Howell
Editor—Alden H. Miller
Associate Editors—Frank A. Pitelka and John Davis
Advertising and Circulation Manager—Jack C. von Bloeker, Jr.

The motion was seconded and carried unanimously.

It was moved that the Society forward the sum of $25 to the International Committee for Bird Preservation to pay for membership dues incurred by the Society during the past year. The motion was seconded and carried unanimously.

It was moved that the Society retain its membership on the International Committee for Bird Preservation for the coming year, and that the regularly scheduled dues for the next membership period be paid. The motion was seconded and carried unanimously.

It was moved that the Society decline with regret the invitation of the South Dakota School of Mines and Technology to hold the 1960 meeting at Rapid City, South Dakota, under the auspices of that institution. The motion was seconded and unanimously carried. The Secretary was directed to explore possibilities for the 1960 annual meeting of the Society. [Subsequent planning has led to scheduling the meeting for Los Angeles.]

The meeting adjourned at 5:15 p.m.—JOHN DAVIS, *Secretary*.

INDEX TO VOLUME 61

By JANE R. DURHAM

A

Acanthis, 394
  flammea holboelli, 230
  hornemanni, 356, 362, 365
  linaria, 362
Accipiter bicolor, 328
  bicolor fidens, 335
  cooperii, 282
  striatus, 282
  striatus velox, 282
Actitis macularia, 284, 413
Aechmophorus occidentalis, 280
Aëronautes saxatalis, 28, 149, 286
Agelaius phoeniceus, 58, 274
Aimophila aestivalis, 139, 145
  aestivalis illinoiensis, 139
  botterii, 136–146
  botterii arizonae, 137, 140, 141, 142, 144, 145
  botterii botterii, 136, 137, 139, 140–145
  botterii goldmani, 137, 140–142, 145
  botterii mexicana, 136, 137, 140–145
  botterii petenica, 136, 137, 139–141, 143–145
  botterii texana, 137, 139, 140–145
  botterii vantynei, 136, 141, 143–145
  botterii vulcanica, 136, 141, 143–145
  cassinii, 399
  quinquestriata, 221
  rufescens, 221, 222, 330
  rufescens pyrgitoïdes, 336
  ruficauda, 221
  ruficeps canescens, 79
  ruficeps simulans, 79
  ruficeps sororia, 79
Aix sponsa, 385
Albatross, Black-footed, 64, 305–314
  Galapagos, 310
  Laysan, 305–314
Alca torda, 431
Alectoris graeca, 283
  graeca cypriotes, 284
Amazilia, 272
  amabilis, 272
  candida, 327
  candida candida, 336
  decora, 272
  edward, 272
  tzacatl, 271, 272, 330, 333
  tzacatl tzacatl, 332, 336
  violiceps, 208, 215
Amblycercus holosericeus, 327
  holosericeus holosericeus, 336
Ammodramus bairdii, 150
Amphispiza belli, 294
  belli nevadensis, 294
  bilineata, 294, 405, 435
Anas acuta, 85, 91, 226, 281, 357, 365
  carolinensis, 229, 281, 357, 365, 438
  crecca carolinensis, 226, 229
  crecca crecca, 227
  discors, 281
  platyrhynchos, 56, 85, 91, 281
  rubripes, 85, 91
  strepera, 281
Anderson, Anders H., and Anderson, Anne, life history of the cactus wren. Part II: the beginning of nesting, 186
Ani, Groove-billed, 81, 214, 330
Anser albifrons, 147
Anthracothorax nigricollis, 272
Anthus spinoletta, 228, 291
  spinoletta blakistoni, 227, 228
  spinoletta japonicus, 228
Antshrike, Barred, 330
Ant-Tanager, Red, 327
  Rosy-throated, 327, 334
Antthrush, Black-faced, 328, 332
Ant-wren, Long-billed, 330, 334
Aphelocoma coerulescens, 53, 60, 79, 288
  coerulescens cactophila, 80
  coerulescens hypoleuca, 79–80, 82
  ultramarina, 53
Aphriza virgata, 225
Aptenodytes patagonica, 13
Aquila chrysaëtos, 283, 358, 365
Araçari, Fiery-billed, 71
Archilochus alexandri, 286, 404
  colubris, 275
Ardea herodias, 60
  herodias fannini, 60
Arenaria interpres, 233
  interpres interpres, 229
  interpres morinella, 229
  melanocephala, 225
Arremon frontalis, 156
Arremonops rufivirgata, 330
  rufivirgatus crassirostris, 336
Asio flammeus, 361, 365
  otus, 56, 285
Asyndesmus lewis, 149, 286
Atlapetes, Chestnut-capped, 327, 334
  Rufous-capped, 335
Atlapetes brunnei-nucha, 156–157, 327, 328, 334
  brunnei-nucha allinornatus, 157
  brunnei-nucha apertus, 334–336
  brunnei-nucha brunnei-nucha, 156, 157
  brunnei-nucha frontalis, 156, 157
  brunnei-nucha inornatus, 157
  brunnei-nucha xanthogenys, 157
Attila, Polymorphic, 330
Attila spadiceus, 330
  spadiceus flammulatus, 336
Aulacorhynchus prasinus, 327
  prasinus prasinus, 336
Auriparus flaviceps, 289, 404

Automolus, Buff-throated, 327, 332
Automolus ochrolaemus, 327, 328
ochrolaemus cervinigularis, 332, 336
Avocet, 169, 371
Aythya americana, 85, 91, 281
collaris, 281
marila, 358, 365
valisineria, 282

B

Bakus, Gerald J., territoriality, movements, and population density of the dipper in Montana, 410
Balanosphyra formicivora albeola, 77, 78
formicivora angustifrons, 77, 78
formicivora bairdi, 77
formicivora formicivora, 77, 78
formicivora lineata, 77, 78
formicivora martirensis, 77
Banks, Richard C., development of nestling white-crowned sparrows in central coastal California, 96
Banks, Richard C., and Johnson, Ned K., pine grosbeak and Lawrence goldfinch in Nevada, 303
Barney, Merle D., red-tailed hawk killing a lamb, 157
Bartholomew, George A., and Howell, Thomas R., further experiments on torpidity in the poor-will, 180
Basileuterus culicivorus, 327, 328
culicivorus culicivorus, 336
rufifrons, 220, 222, 330
rufifrons salvini, 336
Basilinna, 77
Becard, Rose-throated, 208, 216, 330
Blackbird, Brewer, 46, 58, 60, 128, 292, 301, 370
Redwinged, 58, 274
Sumichrast, 329
Yellow-headed, 174, 292
Bluebird, Mountain, 291
Western, 290
Bluethroat, 361, 366
Bobwhite, 213
Bombycilla cedrorum, 291, 438
Booby, Brown, 223, 224
Bowers, Darl E., a study of variation in feather pigments of the wrentit, 38
Brandt, John H., unusual nesting observations in Colorado, 56
Brant, Eastern, 374
Light-bellied, 374
Branta bernicla, 374
canadensis, 281, 427–428
canadensis leucopareia, 281
canadensis minima, 281
canadensis moffitti, 281
Breagyps, 338–340
clarki, 341, 342
Brock, Elbert M., occurrence of the great blue heron in arctic Alaska, 59
Brown, Jerram L., method of head scratching in the wrentit and other species, 53
Brownell, Katharine A., and Hartman, Frank A., liver lipids in hummingbirds, 270
Brush-finch, Chestnut-capped, 156–157
Bubo virginianus, 56, 214, 285, 370, 403
Bubulcus ibis, 30
ibis ibis, 265–269
Bucephala albeola, 54, 282
clangula, 147, 282, 298
islandica, 147, 434
Bufflehead, 54, 282
Bunting, Lark, 293, 295
Lazuli, 293
Snow, 356, 391
Varied, 221, 399, 404, 405
Bushtit, Black-eared, 80
Common, 80, 289
Buss, Irven O., and Nagra, Clarence L., change in body weight associated with onset of ovarian recrudescence and oviposition in pheasants, 348
Buteo, 218
jamaicensis, 56, 85, 92, 157–158, 282
jamaicensis calurus, 304
magnirostris, 330, 335
nitidus, 330, 335
regalis, 283, 304
swainsoni, 56, 282
Buteogallus anthracinus, 330, 335
Butorides virescens, 280, 331
virescens virescens, 335

C

Cacique, Prévost, 327
Calamospiza melanocorys, 293
Calcarius lapponicus, 151, 363, 364, 365
Calidris, 234, 252, 255, 261
temmincki, 247, 251, 252
Callipepla squamata, 404
Calocitta, 221
colliei, 218, 221
formosa colliei, 218
Calypte anna, 161, 275, 371
costae, 286
Campbell, John M., further records of the Hudsonian godwit and Mississippi kite in New Mexico, 370
Campephilus principalis, 378
Campylopterus curvipennis, 329, 332
curvipennis excellens, 332, 336
hemileucurus, 272, 327
hemileucurus hemileucurus, 332, 336
Campylorhynchus brunneicapillus, 186–205, 218, 222, 289, 404
gularis, 218, 222
jocosus, 218
zonatus, 330
zonatus restrictus, 334
zonatus zonatus, 334, 336

Canvasback, 282
Capella gallinago, 284, 359, 365
Caprimulgus carolinensis, 207
europaeus, 183
maculicaudus, 207
ridgwayi, 206–209
vociferus, 207
Caracara, 213
Cardinal, 330, 390, 391
Carpodacus cassinii, 53
mexicanus, 220, 222, 404
Caryothraustes poliogaster, 327, 328
poliogaster poliogaster, 336
Casmerodius albus, 280
Cassidix mexicanus, 220
Catbird, 273, 274
Catharacta skua, 437
Cathartes, 338, 339
aura, 213, 282, 331, 335, 341, 342
Cathartidarum, 339
Cathartornis, 340
gracilis, 341
Catharus aurantiirostris, 210, 219
melpomene, 210
melpomene clarus, 210
mexicanus, 327
mexicanus mexicanus, 336
Catherpes, 403
mexicanus, 218, 222, 289
Catoptrophorus semipalmatus, 284
Celeus castaneus, 328, 336
Centurus aurifrons, 210, 216, 222, 329, 330
aurifrons veraecrucis, 336
carolinus, 386
pucherani, 330
pucherani perileucus, 336
uropygialis, 58, 192, 210, 215, 216, 221, 286, 406, 435
Cepphus grylle, 431
Certhia familiaris, 438
Ceryle torquata, 331, 336
Chachalaca, 370
Common, 330
Chaetura vauxi, 286, 331, 336
Chalybura buffonii, 272
Chamaea, 53
fasciata, 38–45, 53
fasciata henshawi, 38
fasciata intermedia, 38
fasciata rufula, 38
Chamaethlypis poliocephala, 331
poliocephala caninucha, 336
Charadrius collaris, 159
dubius, 173
hiaticula, 170
semipalmatus, 148, 359, 365
vociferus, 173, 284
Chat, Ground, 331
Yellow-breasted, 292, 371
Chen caerulescens, 54
hyperborea, 54, 281
rossii, 54
Chickadee, Black-capped, 97, 99, 101
Mountain, 289
Chicken, Prairie, 250
Rhode Island Red, 89, 90
White Leghorn, 89, 90
Chionis alba, 158, 159
Chlidonias niger, 285
Chloroceryle amazona, 331, 336
americana, 215, 331
americana septentrionalis, 336
Chlorostilbon, 272
canivetii, 272
Chlorura chlorura, 293
Chondestes grammacus, 46, 294, 405
Chordeiles, 207
acutipennis, 215, 286, 404
Chrysolophus amherstiae, 89
pictus, 89
Chuck-wills-widow, 207
Ciccaba virgata, 215
Cinclodes excelsior, 223
Cinclus, 6, 8–10, 14, 16, 17
cinclus, 12, 16, 413, 414
leuconotus, 7
mexicanus, 4–17, 410–426, 438
Circus cyaneus, 56, 283, 369
Cissilopha beecheii, 52
san-blasiana, 52
san-blasiana nelsoni, 52
Clangula hyemalis, 54, 147, 302–303, 358, 365
Claravis pretiosa, opp. 65, 65–74, 329, 331, 335
Coccyzus, 221
americanus, 285
minor, 214, 221
Coffey, Ben B., Jr., the starling in eastern México, 299
Colaptes auratus, 149, 379, 385
cafer, 149, 286
chrysoides, 406
Colibri thalassinus, 272
Colinus virginianus, 213
Columba, 65
fasciata, 73, 76
fasciata fasciata, 76
fasciata letonai, 76
fasciata monilis, 76
fasciata vioscae, 76
flavirostris, 329, 330
flavirostris flavirostris, 335
livia, 58, 85, 92
nigrirostris, 327, 331, 335
speciosa, 327, 335
Columbigallina minuta, 330
minuta interrupta, 335
passerina, 155, 213, 302
talpacoti, 65, 329, 330
talpacoti rufipennis, 335
Condor, California, 338, 342

Contopus cinereus, 330
cinereus brachytarsus, 336
richardsonii, 333
sordidulus, 80
sordidulus peninsulae, 80
Coragyps, 338, 339
atratus, 213, 331, 335, 341, 342
Cormorant, Double-crested, 147, 154, 280
Olivaceous, 331
Corvus brachyrhynchos, 53, 85, 86, 92, 288, 438
caurinus, 391
corax, 218, 288, 356, 361, 365, 403
cryptoleucus, 403
Coturniculus mexicanus, 141
Coturnix coturnix, 430
Cowbird, Brown-headed, 292, 398, 402, 404
Red-eyed, 208, 220, 330
Crane, Sandhill, 359
Crax rubra, 328, 335
Creeper, Brown, 438
Crocethia, 234
Crossbill, Red, 150, 293, 295
White-winged, 150
Crotophaga sulcirostris, 214, 221, 330
sulcirostris pallidula, 81
sulcirostris sulcirostris, 335
Crouch, James E., vermilion flycatchers nesting in San Diego County, California, 57
Crow, Common, 85, 92, 288, 438
Northwestern, 391
Cuckoo, Mangrove, 214
Squirrel, 214, 330
Yellow-billed, 285
Curassow, 328
Cyanerpes cyaneus, 327, 328
cyaneus cyaneus, 336
Cyanocitta cristata, 53, 149
stelleri, 53, 438
Cyanocompsa cyanoides, 327
cyanoides concreta, 334, 336
Cyanocorax yncas, 327, 329, 336
Cynanthus latirostris, 208, 215
Cypseloides niger, 215, 222

D

Davis, John, the Sierra Madrean element of the avifauna of the Cape District, Baja California, 75; a new race of the Mexican pootoo from western México, 300
Davis, John, and Davis, Betty S., red-naped sapsucker in Monterey County, California, 59
Dawson, William R., and Tordoff, Harrison B., relation of oxygen consumption to temperature in the evening grosbeak, 388
Delacour, J., a late seasonal record of the yellow-breasted chat, 371
Dendrocincla anabatina, 327
anabatina anabatina, 336
Dendrocopos major, 373
pubescens, 165, 287, 379, 438
scalaris, 216, 287, 404
villosus, 286, 379
Dendroica auduboni, 55
caerulescens, 55
castanea, 156
coronata, 150
fusca, 158
nigrescens, 292
palmarum, 150, 302
petechia, 291
petechia castaneiceps, 81
petechia morcomi, 292
townsendi, 53, 292
virens, 99
Dichromanassa rufescens, 298
Dickerman, Robert W., and Warner, Dwain W., the status of Rallus elegans tenuirostris in México, 49
Diomedea immutabilis, 305–314
irrorata, 310
nigripes, 305–314
Dipper, 4–17, 410–426
Dives dives, 329
dives dives, 336
Dixon, Keith L., ecological and distributional relations of desert scrub birds of western Texas, 397
Dove, Blue Ground, opp. 65, 65–74, 329, 331
Gray-headed, 328
Ground, 155, 213, 302
Inca, 213
Mourning, 285, 398, 402, 404
Plain-breasted Ground, 330
Ring, 274
Rock, 58, 85, 92
Ruddy Ground, 65, 67, 68
Talpacoti, 329
White-fronted, 65, 214, 327
White-tipped, 65
White-winged, 213, 285, 402, 404
Dowitcher, Long-billed, 148, 284, 359
Dryocopus lineatus, 334
martius, 377, 378
pileatus, 377–387
Du Bois, H. M., black-throated sparrows in northwestern Oregon, 435
Duck, Black, 85, 90, 91
Ring-necked, 281
Ruddy, 282
Wood, 385, 387
Dumetella carolinensis, 273, 274

E

Eagle, Golden, 283, 356, 358, 364, 366
Eckelberry, Don R., the turquoise-browed motmot, 3; painting of turquoise-browed motmots, opp. 3; painting of blue ground dove, opp. 65; painting of gartered trogon, opp. 305

Edwards, Ernest P., and Tashian, Richard E., avifauna of the Catemaco basin of southern Veracruz, México, 325
Egret, Cattle, 30, 265–269
Common, 280
Great, 30
Little, 30–37
Plumed, 30–37
Reddish, 298
Snowy, 54, 267, 281, 331
Egretta alba, 30
garzetta, 30–37
intermedia, 30–37
Eider, Common, 430
Elaenia, Yellow-bellied, 330, 333
Yellow-crowned, 218
Elaenia flavogaster, 330
flavogaster subpagana, 333, 336
Elanus, 153–154
caeruleus, 153
caeruleus leucurus, 153
caeruleus notatus, 153, 154
caeruleus vociferus, 153
leucurus, 301
notatus leucurus, 153
scriptus, 153
Elvira chionura, 272
Emberiza, 170, 436
Emerald, White-bellied, 327
Empidonax difficilis, 53
hammondii, 218, 303
traillii, 97
wrightii, 218
Eremophila alpestris, 287
Ereunetes, 234, 252
mauri, 284
pusillus, 162, 233, 359, 365
Erithacus rubecula, 101, 107
Erolia, 234, 250, 252, 261, 262
acuminata, 261
alpina, 233, 234, 261
bairdii, 165, 233, 234, 261
fuscicollis, 165, 234, 250, 261
melanotos, 161–179, 233–264, 359, 365
minutilla, 169
ptilocnemis, 225
subminuta, 227
temminckii, 227
Escalante, Rodolfo, some records of oceanic birds in Uruguay, 158
Evenden, Fred G., Gullion, Gordon W., and Pulich, Warren M., notes on the occurrence of birds in southern Nevada, 278
Eucometis penicillata, 328
penicillata pallida, 334, 336
Eudyptes crestatus, 158
Eugenes spectabilis, 272
Eumomota superciliosa, opp. 3, 3
Euphagus cyanocephala, 46
cyanocephalus, 53, 58, 60, 128, 292, 301, 370
Eupherusa eximia, 272
Euphonia, Thick-billed, 330
Euthlypis lachrymosa, 219

F

Falco albigularis, 330, 335
columbarius, 283
mexicanus, 283
peregrinus, 260, 283, 356
rusticolus, 148, 260, 356, 358, 365
sparverius, 283, 371
Falcon, Peregrine, 283, 356, 365
Prairie, 283
White-throated, 330
Farner, Donald S., and King, James R., premigratory changes in body weight and fat in wild and captive male white-crowned sparrows, 315
Farner, Donald S., and Serventy, D. L., body temperature and the ontogeny of thermoregulation in the slender-billed shearwater, 426
Fennell, Chester M., Erolia temminckii and Anthus spinoletta blakistoni in Korea, 227
Finch, Black Rosy, 18–29
Brown-capped Rosy, 24, 27
Common House, 220
Gray-crowned Rosy, 18, 25, 28
Hepburn Rosy, 25
House, 398, 399, 402–404
Rosy, 229
Flamingo, American, 156
Flicker, Gilded, 406
Red-shafted, 149, 286
Yellow-shafted, 149, 385
Florisuga mellivora, 272
Flycatcher, Ash-throated, 287, 291, 295, 398, 399, 402, 404, 407
Bent-billed, 328
Boat-billed, 330
Crested, 287
Eye-ringed Flat-billed, 328
Hammond, 218, 303
Kiskadee, 217, 329
Olivaceous, 208, 217, 329
Olive-sided, 287
Pirate, 330
Spade-billed, 327, 333
Streaked, 330
Sulphur-bellied, 217, 329
Sulphur-rumped, 327, 332
Sulphury Flat-billed, 328, 333
Traill, 97–101
Vermilion, 57, 58, 216, 287, 403
Vermilion-crowned, 217, 329
Wied, 217, 330
Wright, 218
Formicarius analis, 328
analis moniliger, 332, 336
Forpus, 221
cyanopygius, 214, 221

Fowl, Domestic, 85, 89, 91, 93
Jungle, 89, 90
Red Jungle, 89
Fratercula arctica, 431
Fregata magnificens, 335
French, Norman R., distribution and migration of the black rosy finch, 18
French, Norman R., and Hodges, Ronald W., torpidity in cave-roosting hummingbirds, 223
Fringilla, 315
Frings, Hubert, and Frings, Mable, observations on salt balance and behavior of Laysan and black-footed albatrosses in captivity, 305
Fulmar, 426
Giant, 158
Fulmarus glacialoides, 426

G

Gadwall, 28
Gallus gallus, 85, 89
Gardner, Leon L., gila woodpecker in San Diego County, California, 435
Gavia arctica, 257, 365
immer, 280
Geococcyx californianus, 285, 404
velox, 214
Geospiza, 53
Geotrygon montana, 327
montana montana, 331, 332, 335
Giller, Donald R., and Selander, Robert K., sympatry of the jays Cissilopha beecheii and C. san-blasiana in Nayarit, 52; the avifauna of the Barranca de Oblatos, Jalisco, México, 210
Gilmore, Raymond M., red phalarope in mid-eastern Pacific, 227
Glaucidium brasilianum, 215, 330
brasilianum ridgwayi, 335
gnoma californicum, 80
gnoma gnoma, 80
gnoma grinnelli, 80
gnoma hoskinsii, 80
Glaucis hirsuta, 272
Gnatcatcher, Black-tailed, 291, 398, 399, 402, 404, 407
Blue-gray, 291
Godwit, Bar-tailed, 356, 359, 366, 367
Hudsonian, 58, 370, 371
Marbled, 55, 58, 163, 284
Goldeneye, Barrow, 147, 434
Common, 147, 282, 298
Goldfinch, American, 293
Lawrence, 303
Lesser, 220, 293
Goodge, William R., locomotion and other behavior of the dipper, 4
Goose, Blue, 54
Canada, 281, 427
Ross, 54
Snow, 54, 281
White-fronted, 147
Grackle, Boat-tailed, 220
Grassquit, Blue-black, 221, 331
Yellow-faced, 331, 334
Grebe, Eared, 299
Horned, 53, 299
Least, 226
Pied-billed, 299, 331
Red-necked, 299
Western, 280
Greenlet, Gray-headed, 327
Tawny-crowned, 327, 334
Grosbeak, Black-faced, 327
Black-headed, 293
Blue, 46–48, 220, 293
Blue-black, 327, 334
Evening, 293, 303, 388–396
Pine, 303, 394
Rose-breasted, 436
Grus canadensis, 359, 365
Guillemot, Black, 431
Guiraca caerulea, 46–48, 220, 293
Gull, Bonaparte, 148
California, 156
Franklin, 226
Glaucous, 361, 366
Great Black-backed, 430
Herring, 154, 430
Kelp, 159
Laughing, 298, 331
Lesser Black-backed, 430
Mew, 361, 430
Patagonian Brown-headed, 159
Ring-billed, 156, 284
Sabine, 64, 148
Western, 431
Gullion, Gordon W., Pulich, Warren M., and Evenden, Fred G., notes on the occurrence of birds in southern Nevada, 278
Gymnogyps, 338, 339
amplus, 341, 342
californianus, 338, 342
Gymnorhinus cyanocephala, 288
Gymnostinops montezuma, 330, 331, 336
Gyrfalcon, 148, 356, 358

H

Habia gutturalis, 327–329
gutturalis littoralis, 336
gutturalis salvini, 334
rubica, 327, 329
rubica rubicoides, 336
Haderlie, Eugene C., and Haderlie, Aileen E., longevity of an injured scrub jay, 60
Haematopus ostralegus, 169
Hailman, Jack P., unusual "bunching" behavior of starlings, 369; a third head-scratching method of emberizine sparrows, 435
Halocyptena microsoma, 373

Hamilton, William J., III, aggressive behavior in migrant pectoral sandpipers, 161
Hand, Ralph L., Hoffmann, Robert S., and Wright, Philip L., recent bird records from western Montana, 147
Hardy, John William, and Johnston, Richard F., the Ridgway whip-poor-will and its associated avifauna in southwestern New Mexico, 206
Hartman, Frank A., and Brownell, Katherine A., liver lipids in hummingbirds, 270
Hawk, Bicolored, 328
Cooper, 282
Crab, 330
Ferruginous, 283, 304
Gray, 330
Insect, 330
Marsh, 56, 283, 369
Pigeon, 283
Red-tailed, 56, 85, 92, 157–158, 282, 304
Rough-legged, 365
Sharp-shinned, 282
Sparrow, 283, 371
Swainson, 56, 282
White, 327
Hawk-Owl, 149
Heliodoxa jacula, 272
Henicorhina leucosticta, 327, 328
leucosticta prostheleuca, 336
Hermit, 327, 331
Longuemare, 328, 332
Heron, Black-crowned Night, 30–37, 281
Green, 280
Little Green, 331
Hesperiphona vespertina, 293, 303
vespertina vespertina, 388–396
Heteropygia maculata, 247
Himantopus mexicanus, 284
Hirundo rustica, 99, 218, 288, 369
Hodges, Ronald W., and French, Norman R., torpidity in cave-roosting hummingbirds, 223
Hoffmann, Robert S., Hand, Ralph L., and Wright, Philip L., recent bird records from western Montana, 147
Honeycreeper, Blue, 327
Howell, Thomas R., land birds from Clipperton Island, 155; a hybrid of the pintail and green-winged teal, 226
Howell, Thomas R., and Bartholomew, George A., further experiments on torpidity in the poor-will, 180
Huey, Laurence M., the second occurrence of a brown booby near Parker Dam on the Colorado River, 223
Hummingbird (see also Emerald and Hermit)
Anna, 161, 223, 275, 371
Black-chinned, 286, 404
Blue-throated, 215
Broad-billed, 208, 215
Broad-tailed, 286
Costa, 286
Rieffer, 330, 332, 333
Ruby-throated, 275
Rufous, 286
Rufous-tailed, 271
Scintillant, 271
Violet-crowned, 208, 215
Xantus, 77
Husain, K. Z., notes on the taxonomy and zoogeography of the genus Elanus, 153
Hydroprogne caspia, 149
Hylocharis, 77
leucotis, 77
xantusii, 77
Hylocichla guttata, 290
guttata nanus, 290
ustulata, 290
Hylomanes momotula, 328
momotula momotula, 336
Hylophilus decurtatus, 327–329, 334
decurtatus decurtatus, 336
ochraceiceps, 327, 329
ochaceiceps ochraceiceps, 334, 336

I

Ibis, White-faced, 281
Icteria virens, 292
Icterus bullockii, 58, 222, 292
cucullatus, 220, 292
mesomelas, 330
mesomelas mesomelas, 336
parisorum, 292, 404
prosthemelas, 330, 331
prosthemelas prosthemelas, 336
pustulatus, 220, 221
spurius, 438
wagleri, 220, 222
Ictinia misisippiensis, 59, 370, 371
Iridoprocne albilinea, 331, 336
bicolor, 54, 165, 288
Ixoreus naevius, 149

J

Jacana, 331
spinosa, 331, 335
Jaeger, Long-tailed, 64, 148, 351, 358, 360–361, 366, 367
Parasitic, 64, 351, 358, 360–361, 366
Pomarine, 64, 255, 259
Jay, Blue, 53, 149
Brown, 330
Canada, 149
Gray, 229, 391, 392
Green, 327
Piñon, 288
Scrub, 53, 60, 79, 288
Steller, 53, 149, 438
Jeter, Horace H., cliff swallows of mixed plumage types in a colony in southeastern Arizona, 434

Johnsgard, Paul A., and Sibley, Charles G., variability in the electrophoretic patterns of avian serum proteins, 85
Johnson, Myrtle E., another record of the orchard oriole in California, 437
Johnson, Ned K., and Banks, Richard C., pine grosbeak and Lawrence goldfinch in Nevada, 303
Johnston, Richard F., and Hardy, John William, the Ridgway whip-poor-will and its associated avifauna in southwestern New Mexico, 206
Junco, Baird, 79
Gray-headed, 294, 438
Oregon, 110–135
Slate-colored, 86, 92, 110, 128, 294, 346, 436
Junco, 315
alticola, 79
bairdi, 79
caniceps, 294, 438
fulvescens, 79
hyemalis, 86, 92, 110, 294, 436
oreganus, 110–135
phaeonotus, 79
phaeonotus palliatus, 79

K

Kilham, Lawrence, bark-eating of red-headed woodpeckers, 371; behavior and methods of communication of pileated woodpeckers, 377
Killdeer, 148, 173, 284
King, James R., and Farner, Donald S., premigratory changes in body weight and fat in wild and captive male white-crowned sparrows, 315
King, Joseph E., Franklin gull in the central Pacific, 226
Kingbird, Thick-billed, 208, 217
Tropical, 70, 217, 329, 333
Western, 58, 287
Kingfisher, Belted, 286
Big Green, 331
Little Green, 215, 331
Ringed, 331
Kinglet, Golden-crowned, 291
Ruby-crowned, 291, 371
Kite, Mississippi, 59, 370, 371
White-tailed, 30, 64
Kittiwake, 431

L

Lagopus lagopus, 356, 358, 365
Lampornis castaneoventris, 272
clemenciae, 215, 222
Lanio aurantius, 327, 329
aurantius aurantius, 334, 336
Lanius excubitor, 362, 365, 366
ludovicianus, 222, 291, 404
Lapwing, 161, 165
Lark, Horned, 151, 287, 295
Larus, 431
argentatus, 154, 430
atricilla, 331, 335
canus, 361, 365, 430
delawarensis, 284
fuscus, 430
hyperboreus, 361, 365
marinus, 430
marinus dominicanus, 159
occidentalis, 431
philadelphia, 148
pipixcan, 226
ridibundus maculipennis, 159
Legatus leucophaius, 330
leucophaius variegatus, 336
Legg, Ken, occurrences of the mockingbird at the northwestern margin of its range, 438
Lehmann V., F. C., observations on the cattle egret in Colombia, 265
Lepidocolaptes souleyettii, 328
souleyettii insignis, 336
Leptotila, 65
plumbeiceps, 328
plumbeiceps plumbeiceps, 335
verreauxi, 65, 214, 327, 328
verreauxi fulviventris, 335
Leucophoyx thula, 54, 267, 281, 331, 335
Leucopternis albicollis, 327
albicollis ghiesbreghti, 335
Leucosticte atrata, 393
tephrocotis, 393
tephrocotis atrata, 18–29
tephrocotis australis, 21, 28
tephrocotis kadiaka, 229
tephrocotis littoralis, 25
tephrocotis tephrocotis, 18–21, 23, 25, 28
tephrocotis wallowa, 21, 28
Levy, Seymour H., the least grebe recorded again in Arizona, 226
Limnodromus scolopaceus, 148, 284, 359, 365
Limosa fedoa, 55, 58, 163, 284
haemastica, 58, 370
lapponica, 359, 365, 366
Lindley, Phyllis, Brewer blackbirds in the Sierra Nevada, California, 60
Lobipes lobatus, 148, 360, 365
Longhurst, William M., an unusual concentration of white-tailed kites in Napa County, California, 301
Longspur, Alaska, 230
Lapland, 151, 230, 255, 364, 366
Loomelania melanis, 373
Loon, Arctic, 357
Common, 280
Lophodytes cucullatus, 282
Lophortyx californicus, 283
gambelii, 280
Lophura nycthemera, 89
Loxia, 394
curvirostra, 293
leucoptera, 150

Luscinia svecica, 361, 365

M

Machetes, 261
Macronectes giganteus, 158
Magpie, Black-billed, 56, 438
Magpie-jay, 218
Maher, William J., habitat distribution of birds breeding along the upper Kaolak River, northern Alaska, 351
Mallard, 56, 85, 89, 90–92, 170, 281
Manakin, Yellow-thighed, 328, 332
Marshall, David B., new bird records from southeastern Oregon, 53
Marshall, Joe T., Jr., and Moore, Robert T., a new race of screech owl from Oaxaca, 224
Martin, Purple, 288, 295
McClure, H. Elliott, Yoshii, M., Okada, K., and Scherer, W. F., a method for determining age of nestling herons in Japan, 30
McMillan, Eben, starlings nesting in central California, 157
Meadowlark, Western, 292
Megaceryle alcyon, 286
Megadyptes antipodes, 427
Megarhynchus pitangua, 330
  pitangua mexicanus, 336
Megascops vinaceus, 225
Melanerpes erythrocephalus, 371
Melanotis caerulescens, 219
Melopsittacus undulatus, 93, 274
Melospiza georgiana, 274
  lincolnii, 127
  lincolnii alticola, 229
  lincolnii lincolnii, 229
  melodia, 126, 295, 436, 438
  melodia gouldii, 96
Melozone, 221
  kieneri, 221
Merganser, Hooded, 282
  Red-breasted, 282, 358, 366
Mergus serrator, 282, 358, 365
Micrathene whitneyi, 399, 404
Micropalama himantopus, 148, 176
Miller, Alden H., response to experimental light increments by Andean sparrows from an equatorial area, 344
Miller, F. W., the Barrow goldeneye in Texas, 434
Mimus polyglottos, 59, 161, 219, 289, 404, 438
Mockingbird, 59, 161, 289, 374, 398, 399, 401, 402, 404, 436, 438
  Blue, 219
  Northern, 219
Molothrus ater, 292, 404
  ater obscurus, 293
Momotus mexicanus, 3, 215, 221
  momota, 3, 327
  momota lessonii, 336
Montgomery, Vester, four recent records from southeastern New Mexico, 58
Moore, Robert T., and Marshall, Joe T., Jr., a new race of screech owl from Oaxaca, 224
Morley, Arthur, notes on occurrences of birds in San Diego County, California, 302; brown thrasher in San Diego, California, 374
Motacilla alba lugens, 228
  flava, 361, 365
Motmot, Blue-crowned, 3, 327
  Russet-crowned, 3, 215
  Tody, 328
  Turquoise-browed, opp. 3, 3, 61
Murre, Common, 431
Murrell, Stuart L., the eastern brant at Humboldt Bay, California, 374
Myadestes townsendi, 291, 438
  unicolor, 327
  unicolor unicolor, 334, 336
Myiarchus, 217, 405
  cinerascens, 287, 404
  tuberculifer, 208, 217, 329
  tuberculifer lawrencei, 336
  tyrannulus, 217, 287, 330
Myiobius sulphureipygius, 327
  sulphureipygius sulphureipygius, 332, 336
Myiodynastes luteiventris, 217, 221, 329
  luteiventris luteiventris, 336
  maculatus, 330
  maculatus insolens, 336
Myiopagis, 218, 221
  viridicata, 218, 221
Myiozetetes, 217
  similis, 217, 329
  similis texensis, 336

N

Nagra, Clarence L., and Buss, Irven O., change in body weight associated with onset of ovarian recrudescence and oviposition in pheasants, 348
Nighthawk, Lesser, 286
  Trilling, 215, 398, 402, 404, 405, 407
Nightingale-Thrush, Black-headed, 327
  Orange-billed, 219
Nightjar, 183
  Buff-collared, 206–209
Novaes, Fernando C., Procellaria aequinoctialis on Amazon River in Brazil, 299
Nucifraga columbiana, 288
Numenius arquata, 172
  phaeopus, 367
Nutcracker, Clark, 149, 288, 295
Nuthatch, Pygmy, 55, 289, 438
  Red-breasted, 289
  White-breasted, 76, 78
Nuttallornis borealis, 287
Nyctea scandiaca, 356
Nyctibius griseus, 300
  griseus jamaicensis, 300
  griseus lambi, 300
  griseus mexicanus, 300
Nycticorax nycticorax, 30–37, 281

Nyctidromus albicollis, 207, 330
albicollis yucatanensis, 336

O

Oceanites oceanicus, 426, 429, 430
Oceanodroma homochroa, 373
leucorhoa, 373, 426–428, 431
Odontophorus guttatus, 327, 335
Okada, Y., Scherer, W. F., McClure, H. Elliott, and Yoshii, M., a method for determining age of nestling herons in Japan, 30
Oldsquaw, 54, 147, 302–303, 358
Olor buccinator, 147
columbianus, 281
Oncostoma cinereigulare, 328, 336
Oporornis agilis, 158
tolmiei, 292
Oreopeleia, 65
montana, 73
Oreoscoptes montanus, 46, 290
Oreotrochilus chimborazo, 223
Orians, Gordon H., a review of hawks, owls and wildlife, by Craighead and Craighead, 61
Oriole, Black-cowled, 330
Bullock, 58, 292
Hooded, 220, 292
Orchard, 437–438
Scarlet-headed, 220
Scott, 292, 295, 398, 399, 402, 404, 407
Wagler, 220
Yellow-tailed, 330
Oropendola, Montezuma, 330
Ortalis vetula, 330, 335, 370
Osprey, 283
Otus asio, 224, 225, 285, 304, 406
asio cardonensis, 77
asio cineraceus, 77, 224, 285
asio lambi, 224, 225
asio quercinus, 77
asio seductus, 224, 225
asio sinaloensis, 77, 224, 225
asio vinaceus, 224
asio xantusi, 76–77
asio yumanensis, 77, 285
chiapensis chiapensis, 224
cooperi, 225
cooperi chiapensis, 224
cooperi cooperi, 224
Ouzel, Water, 413, 438
Owl, Barn, 214, 285
Burrowing, 285
Elf, 398, 399, 402, 404, 406
Great Horned, 214, 285, 370
Horned, 403
Long-eared, 56, 285
Pygmy, 80
Screech, 76–77, 81, 224, 285, 304, 406
Short-eared, 361
Snowy, 356
Spotted, 149
Squamulated, 215
Streaked Pygmy, 215, 330
Oxyura jamaicensis, 282
Oystercatcher, 169

P

Pachyptila belcheri, 158
turtur, 426, 427, 428
Palaeogyps, 338–340
prodromus, 341
Pandion haliaetus, 283
Parakeet, Grass, 93
Parauque, 207, 330
Parkes, Kenneth C., subspecific status of Atlapetes brunnei-nucha in South America, 156
Parrot, Red-eared, 328
Parrotlet, Mexican, 214
Partridge, Chukar, 283
Spotted, 327
Parula pitiayumi, 219
Parus, 394
atricapillus, 97
gambeli, 289
inornatus, 289
major, 124
Passer domesticus, 56, 58, 97, 220, 292
Passerculus, 363
sandwichensis, 294, 363, 365
sandwichensis crassus, 229
sandwichensis nevadensis, 294
Passerella iliaca, 295, 436
Passerina amoena, 293
versicolor, 221, 404
Pelecanus erythrorhynchos, 147, 280, 298
occidentalis, 331, 335
Pelican, Brown, 331
White, 147, 280, 298
Penguin, King, 13
Magellanic, 158
Rockhopper, 158
Yellow-eyed, 427
Perdix perdix, 283
Perisoreus canadensis, 391
canadensis arcus, 229
canadensis pacificus, 229
Petrel, Ashy, 64, 373
Black, 64, 373
Leach, 64, 373, 426
Least, 64, 373
Wilson, 426
Petrochelidon fulva, 3, 369, 370
pyrrhonota, 99, 124, 218, 288, 369, 370, 434
pyrrhonota melanogaster, 434
pyrrhonota mimima, 434
pyrrhonota tachina, 434
Peucaea aestivalis arizonae, 140
sartorii, 139
Pewee, Tropical, 330
Western Wood, 80, 333
Peyton, Leonard J., and Williamson, Francis S. L., breeding record of the double-crested cormorant in south-central Alaska, 154

Phaeochroa cuvierii, 272
Phaethornis guy, 272
longuemareus, 272, 328
longuemareus adolphi, 332, 336
superciliarus, 272
superciliosus, 327, 332
superciliosus veraecrucis, 331, 336
Phainopepla, 55, 295, 399, 404
Phainopepla nitens, 55, 404
Phalacrocorax auritus, 147, 154, 280
olivaceus, 331, 335
Phalaenoptilus, 207
nuttallii, 149, 180–185, 206, 286, 404
Phalarope, Northern, 148, 356, 360
Red, 227, 233–234, 237, 246, 258–259, 261, 360, 366
Wilson, 148, 284
Phalaropus fulicarius, 227, 233, 360, 365
Phasianus colchicus, 85–87, 348–350, 430
Phasmagyps, 338, 340
Pheasant, Golden, 89
Lady Amherst, 89
Reeves, 89
Ring-necked, 85–89, 91, 93, 348–350, 430
Silver, 89
Pheucticus ludovicianus, 436
melanocephalus, 53, 293
Philomachus, 234, 261
pugnax, 262
Phloeoceastes guatemalensis, 52
Phlogothraupis sanguinolenta, 330
sanguinolenta sanguinolenta, 336
Phoebe, Black, 216, 287, 331–332, 403
Eastern, 99–100
Say, 57, 287, 369, 403
Piaya cayana, 214, 330
cayana thermophila, 335
Pica nuttalli, 53
pica, 56, 438
Picoides arcticus, 303
Piculus rubiginosus, 330
rubiginosus yucatanensis, 336
Pigeon, Band-tailed, 73, 76
Red-billed, 329
Scaled, 327
Short-billed, 327, 331
Pinicola enucleator, 303, 393
enucleator californica, 303
Pintail, 85, 89, 91, 226, 227, 281, 357, 366
Pionopsitta haematotis, 328
haematotis haematotis, 335
Pipilo aberti, 293, 406
erythrophthalmus, 78–79, 293, 438
erythrophthalmus clementae, 78
erythrophthalmus magnirostris, 78–79
erythrophthalmus montanus, 293
erythrophthalmus umbraticola, 79
fuscus, 53, 184, 222, 404
fuscus albigula, 75, 79
fuscus mesoleucus, 75
Pipit, Blakiston Water, 228
Water, 151, 291
Pipra mentalis, 328
mentalis mentalis, 332, 336
Pipromorpha, Oleaginous, 327, 333
Pipromorpha oleaginea, 327, 329, 334
oleaginea assimilis, 333, 336
Piranga bidentata, 220, 222
flava, 220
leucoptera, 327
leucoptera leucoptera, 336
ludoviciana, 293
rubra, 98, 156, 293, 334
rubra rubra, 156
Pisobia, 261
Pitangus sulphuratus, 217, 221, 329
sulphuratus derbianus, 336
Pitelka, Frank A., numbers, breeding schedule and territoriality in pectoral sandpipers of northern Alaska, 233
Platypsaris aglaiae, 208, 216, 320
aglaiae sumichrasti, 336
Platyrinchus mystaceus, 327
mystaceus cancrominus, 333, 336
Plectrophenax nivalis, 356, 391
Plegadis chihi, 281
Pliogyps, 338–343
fisheri, 338–343
Plover, American Golden, 359
Black-bellied, 54, 148
Golden, 159, 233, 353, 356, 366
Little Ringed, 173
Ringed, 170
Semipalmated, 148, 359, 366
Snowy, 156
Pluvialis dominica, 233, 359, 365
Podiceps auritus, 53, 299
caspicus, 299
dominicus, 226
dominicus bangsi, 226
grisegena, 299
Podilymbus podiceps, 299, 331, 335
Polioptila caerulea, 291
melanura, 291, 404
Polyborus cheriway, 213
Pooecetes gramineus, 294
Poor-will, 149, 180–185, 206–207, 286, 398, 399, 402, 404, 405
Pootoo, Mexican, 300
Porzana carolina, 284
Prion, Fairy, 426
Procellaria aequinoctialis, 299
Progne subis, 222, 288
Protonotaria citrea, 99
Psaltriparus melanotis, 80
minimus, 53, 80, 289
minimus grindae, 80, 82
Psilorhinus morio, 330, 336
Ptarmigan, Willow, 356, 358, 361, 366
Pteroglossus frantzii, 71
torquatus torquatus, 336

Puffin, Common, 431
Puffinus carneipes, 374
creatopus, 374
griseus, 158, 374
tenuirostris, 426–433
Pulich, Warren M., Evenden, Fred G., and Gullion, Gordon W., notes on the occurrence of birds in southern Nevada, 278
Pyrocephalus rubinus, 57–58, 216, 287, 403
Pyrrhuloxia, 192, 204, 398, 399, 401, 402, 404, 407
Pyrrhuloxia sinuata, 192, 404

Q

Quail, California, 283
Gambel, 280
Scaled, 398, 402, 404
Quail-Dove, Ruddy, 73, 327, 331–332

R

Rainey, Dennis G., Van Hoose, S. G., and Tramontano, John, breeding of the starling in southern California, 57
Rallus elegans, 50
elegans elegans, 50
elegans tenuirostris, 49–51
longirostris, 49, 50
longirostris beldingi, 50
longirostris grossi, 50
longirostris pallidus, 50, 51
longirostris rhyzophorae, 50, 51
longirostris tenuirostris, 49, 50
Ramphastos sulfuratus, 329, 336
Ramphocaenus rufiventris, 330
rufiventris rufiventris, 334, 336
Raven, 361
Common, 288, 356
Holarctic, 218
Razorbill, 431
Rechnitzer, Andreas B., flamingo in a southern California slough, 156
Recurvirostra americana, 371
avosetta, 169
Redhead, 85, 89, 91, 281
Redpoll, 356, 362–363, 366
Regulus calendula, 291, 371
satrapa, 291
Reuther, Ronald T., European starling nesting in the San Joaquin Valley, California, 57
Rhynchocyclus brevirostris, 328
brevirostris brevirostris, 336
Richmondena cardinalis, 330, 390, 391
cardinalis coccinea, 336
Rickard, W. H., changes in winter bird species composition of two habitats in San Miguel County, New Mexico, after three-fourths of a century, 438
Riparia riparia, 288
riparia maximiliani, 229
riparia riparia, 229
Rissa tridactyla, 431
Roadrunner, 285
California, 402, 404
Lesser, 214
Robertson, John McB., ruby-crowned kinglet feeding on nectar, 371
Robin, 76, 80, 97–98, 100, 107, 174, 290, 413
Clay-colored, 329
English, 101
White-necked, 327
Ruff, 234, 255, 261–263
Rynchops nigra, 298

S

Sabine, Winifred S., the winter society of the Oregon junco: intolerance, dominance, and the pecking order, 110
Sabre-wing, 329, 332
DeLattre, 327, 332
Salpinctes obsoletus, 218, 222, 289, 403
Saltator, Black-headed, 329, 334
Gray, 330
Saltator atriceps, 329
atriceps suffuscus, 334, 336
coerulescens, 330
coerulescens grandis, 336
Sams, James R., ground doves nesting in San Diego County, 155
Sams, James R., and Stott, Ken, Jr., distributional records of the common goldeneye and the crissal thrasher in southeastern California, 298
Sandpiper, Baird, 165, 233
Least, 150, 169, 174
Pectoral, 150, 161–179, 233–264, 356, 359
Red-backed, 233, 238, 256
Rock, 225
Semipalmated, 162, 175, 233, 238, 356, 359
Sharp-tailed, 261
Siberian Pectoral, 261
Solitary, 64, 173, 284
Spotted, 284, 366, 413
Stilt, 148, 176
Western, 284
White-rumped, 165, 250, 261
Sapsucker, Red-naped, 59
Yellow-bellied, 373, 386
Sarcoramphus, 338–339
fossilis, 339
kernense, 339
papa, 331, 335, 338–342
Sayornis nigricans, 216, 222, 287, 331, 403
nigricans nigricans, 332, 336
phoebe, 99
saya, 57, 287, 369, 403
Scardafella inca, 213, 330, 335
Scaup, Greater, 358, 366
Scherer, W. F., McClure, H. Elliott, Yoshii, M., and Okada, Y., a method for determining age of nestling herons in Japan, 30
Seedeater, White-collared, 221, 331
Seiurus aurocapillus, 53, 98

motacilla, 53, 336
noveboracensis, 53
Selander, Robert K., and Giller, Donald R., sympatry of the jays Cissilopha beechii and C. san-blasiana in Nayarit, 52; the avifauna of the Barranca de Oblatos, Jalisco, México, 210
Selasphorus, 272
platycercus, 286
rufus, 286
scintilla, 271, 272, 274
Serventy, D. L., and Farner, Donald S., body temperature and the ontogeny of thermoregulation in the slender-billed shearwater, 426
Setophaga ruticilla, 333
Shearwater, Manx, 64
Pale-footed, 64, 373–374
Pink-footed, 64, 374
Slender-billed, 426–433
Sooty, 64, 158, 374
Sheath-bill, 158–159
Shoemaker, 299
Shoveler, 54, 281
Shrike, Loggerhead, 291, 295, 402, 404
Northern, 362, 366
Shrike-Tanager, 327, 334
Sialia currucoides, 291
mexicana, 290
Sibley, Charles G., and Johnsgard, Paul A., variability in the electrophoretic patterns of avian serum proteins, 85
Siskin, Pine, 293, 295, 438
Sitta, 394
canadensis, 289
carolinensis aculeata, 78
carolinensis alexandrae, 78
carolinensis lagunae, 78
carolinensis mexicana, 78
carolinensis nelsoni, 78
carolinensis umbrosa, 78
pygmaea, 55, 289, 438
Sittasomus griseicapillus, 327
griseicapillus sylvioides, 336
Skimmer, Black, 298
Skua, 437
Skutch, Alexander F., life history of the blue ground dove, 65
Small, Arnold, rock sandpipers in southern California, 225; recent occurrences of oldsquaw in southern California, 302; more observations of the least petrel and pale-footed shearwater off southern California, 373; some additional records of the skua from California, 437
Snipe, Common, 284, 359
Solitaire, Slate-colored, 327, 334
Townsend, 291, 438
Somateria mollissima, 430
Sora, 284
Sparrow, Andean, 344–347
Bachman, 139
Baird, 150
Black-throated, 291, 294, 295, 398, 402, 405, 435
Botteri, 136–146
Brewer, 150, 151, 294
Cassin, 399
Chipping, 294
English, 196, 202
Five-striped, 221
Fox, 230, 295, 436
Golden-crowned, 295, 344, 347
Harris, 55, 151
House, 56, 58, 97, 99, 220, 292
Lark, 46, 294, 399, 405
Lincoln, 127, 229
Olive, 330
Rufous-crowned, 79, 81
Russet-tailed, 221
Rusty, 221, 330
Rusty-crowned Ground, 221
Sage, 294
Savannah, 150, 229, 230, 294, 362, 363, 366
Song, 96, 100, 101, 126, 198, 230, 295, 436, 438
Tree, 86, 92, 97, 100, 101, 112, 294, 363, 364, 366, 436
Vesper, 151, 294
White-crowned, 55, 96–109, 151, 276, 294, 315–324, 344, 347, 364
White-throated, 55, 295, 316, 346
Spatula clypeata, 54, 281
Speotyto cunicularia, 285
Spheniscus magellanicus, 158
Sphyrapicus varius, 373, 386
varius daggetti, 59
varius nuchalis, 59
varius varius, 59
Spinetail, Rufous-breasted, 330
Spinus lawrencei, 53, 303
pinus, 293, 438
psaltria, 53, 220, 293
tristis, 293
Spizella arborea, 86, 92, 97, 112, 294, 363, 365, 436
breweri, 53, 150, 294
passerina, 294
Sporophila torqueola, 221, 331
torqueola morelleti, 336
Squatarola squatarola, 54, 148
Stabler, Robert M., nesting of the blue grosbeak in Colorado, 46
Starling, 57, 58, 160, 274, 299, 301–302, 369, 373, 436
European, 57, 86, 92, 157
Steganopus tricolor, 284
Stelgidopteryx ruficollis, 3, 218, 288
Stercorarius longicaudus, 148, 360, 365
parasiticus, 260, 360, 365
Stern, Ralph J. A., mockingbird observed on the southern tip of Tiburon Peninsula, Marin County, California, 59

Sterna albifrons, 298
antillarum, 59
paradisaea, 361, 365
Stilt, Black-necked, 284
Stint, Temminck, 227
Storer, Robert W., the arrangement of songbird families, 152
Stott, Ken, Jr., red-necked grebe in San Diego County, California, 299; the starling arrives in San Diego, California, 373
Stott, Ken, Jr., and Sams, James R., distributional records of the common goldeneye and the crissal thrasher in southeastern California, 298
Streptopelia risoria, 274
Strix occidentalis, 149
Sturnella magna, 222
neglecta, 292
Sturnus vulgaris, 57, 86, 92, 157, 274, 299, 301–302, 369, 373, 436
Sula leucogaster brewsteri, 223
Surfbird, 225
Surnia ulula, 149
Swallow, Cave, 3, 369–370
Bank, 229, 288
Barn, 99, 218, 288, 369–370
Cliff, 99, 124, 218, 288, 369–370, 434
Mangrove, 331
Rough-winged, 3, 218, 288
Tree, 55, 165, 174, 288
Violet-green, 106, 288
Swan, Trumpeter, 147
Whistling, 147, 281
Swift, Black, 215
White-throated, 28, 149, 223, 286
Vaux, 286, 331
Synallaxis erythrothorax, 330
erythrothorax furtiva, 336
Syrmaticus reevesi, 89

T

Tachycineta thalassina, 106, 288
Tanager, Abbot, 329, 334
Blue-gray, 330
Crimson-collared, 330
Gray-headed, 328, 334
Hepatic, 220
Summer, 98, 156, 293, 334
Swainson, 220
Western, 293
White-winged, 327
Tanagra lauta, 330
lauta lauta, 336
Tangavius aeneus, 208, 220, 330, 336
Tashian, Richard E., and Edwards, Ernest P., avifauna of the Catemaco Basin of southern Veracruz, México, 325
Teal, Blue-winged, 281
Green-winged, 226, 227, 229, 281, 357, 366, 438
Telmatodytes palustris, 100
Teratornis, 339–340, 342
merriami, 338–339, 341–342
Tern, Arctic, 64, 361, 366
Black, 285
Caspian, 149
Cayenne, 158
Least, 59, 298
Thalasseus eurygnathus, 158
Thamnophilus doliatus, 330
doliatus intermedius, 336
Thrasher, Bendire, 290, 295
Brown, 55, 374
Crissal, 290, 295, 298, 399, 404
Curve-billed, 195–196, 204, 219, 290, 398, 404
Le Conte, 290, 295
Sage, 46, 290
Thraupis abbas, 329, 334, 336
virens, 330
virens diaconus, 336
Thrush, Hermit, 290
Olive-backed, 230
Rufous-backed, 219
Swainson, 290
Varied, 149
White-necked, 219
Thryomanes bewickii, 53, 218, 222, 404
Thryothorus maculipectus, 329, 330
maculipectus maculipectus, 336
sinaloa, 218
Tiaris olivacea, 331
olivacea pusilla, 334, 336
Tit, Great, 124, 126, 128
Titmouse, Plain, 289
Tityra, Masked, 330
Tityra semifasciata, 330
semifasciata personata, 336
Tolmomyias sulphurescens, 328, 333
sulphurescens cinereiceps, 336
Tordoff, Harrison B., a condor from the Upper Pliocene of Kansas, 338
Tordoff, Harrison B., and Dawson, William R., relation of oxygen consumption to temperature in the evening grosbeak, 388
Totanus flavipes, 163, 284
melanoleucus, 163, 284
Toucan, Keel-billed, 329
Toucanet, Emerald, 327
Towhee, Abert, 293, 406
Brown, 75–76, 79, 81, 184, 399, 402, 404, 406
Green-tailed, 293
Rufous-sided, 78, 81, 293
Spotted, 438
Toxostoma, 405
bendirei, 290
curvirostre, 219, 290, 404
dorsale, 290, 298, 404
lecontei, 290
lecontei lecontei, 290
rufum, 55, 374

Tramontano, John, Rainey, Dennis G., and Van Hoose, S. G., breeding of the starling in southern California, 57
Tree-runner, Least, 327
Tringa solitaria, 173, 284
Troglodytes musculus, 330
musculus intermedius, 336
Trogon, Collared, 327
Coppery-tailed, 208, 215
Gartered, opp. 305, 327
Trogon, 215, 221
ambiguus, 215
citreolus, 215, 221
collaris, 327
collaris puella, 336
elegans, 208, 215
violaceus, opp. 305, 327, 329
violaceus braccatus, 336
Turdus assimilis, 219, 327–328
assimilis leucauchen, 336
grayi, 329–330
grayi grayi, 336
migratorius, 80, 97, 174, 290, 413
migratorius confinis, 80
rufo-palliatus, 219, 221
Turkey, 89
Turnstone, Black, 225
European, 229
Ruddy, 229, 233
Tympanuchus cupido, 250
Tyrannus, 218
crassirostris, 208, 217, 222
melancholicus, 70, 217, 221, 329, 333
melancholicus chloronotus, 336
verticalis, 58, 287
Tyto alba, 214, 285

U

Uria aalge, 431

V

Vanellus vanellus, 161, 165
Van Hoose, S. G., Tramontano, John, and Rainey, Dennis G., breeding of the starling in southern California, 57
Veniliornis fumigatus, 330
fumigatus sanguinolentus, 336
Verdin, 289, 295, 398, 399, 402, 404, 407
Vermivora celata, 291
luciae, 406
peregrina, 156
ruficapilla, 149, 291
Vireo, Bell, 291, 399, 402, 404
Golden, 219
Gray, 291
Hutton, 78
Red-eyed, 329
Solitary, 80, 291
Warbling, 76, 78, 291
Yellow-green, 219
Vireo bellii, 291, 404
flavoviridis, 219, 221
gilvus, 291
gilvus amauronotus, 78
gilvus brewsteri, 78
gilvus gilvus, 78
gilvus leucopolius, 78
gilvus swainsonii, 78
gilvus victoriae, 76, 78
huttoni, 78
huttoni carolinae, 78
huttoni cognatus, 78
huttoni huttoni, 78
huttoni mexicanus, 78
huttoni stephensi, 78
hypochryseus, 219, 221
olivaceus, 329, 330
olivaceus flavoviridis, 336
solitarius, 291
solitarius cassinii, 80
solitarius lucasanus, 80, 82
solitarius pinicolus, 80
solitarius plumbeus, 80
solitarius repetens, 80
solitarius solitarius, 80
vicinior, 291
Volatinia jacarina, 221, 331
jacarina splendens, 336
Vultur, 338–339
fossilis, 339
gryphus, 339
patruus, 339
Vulture, Black, 213, 331
King, 331, 338–339
Turkey, 213, 282, 331

W

Wagtail, Pied, 228
Yellow, 361
Walker, Alex., Blackburnian and Connecticut warblers in Montana, 158
Warbler, Audubon, 55
Bay-breasted, 156
Blackburnian, 158
Black-throated Blue, 55
Black-throated Gray, 292
Black-throated Green, 99
Connecticut, 158
Fan-tailed, 219
Golden-crowned, 327
Lucy, 406
Lutescent, 230
MacGillivray, 292
Mangrove, 81
Myrtle, 150
Nashville, 149, 291
Olive-backed, 219
Orange-crowned, 291
Palm, 150, 302
Prothonotary, 99–100
Rufous-capped, 220, 330
Tennessee, 156
Townsend, 292
Wilson, 292
Yellow, 291

Warner, Dwain W., and Dickerman, Robert W., the status of Rallus elegans tenuirostris in México, 49
Waterthrush, Louisiana, 53
Northern, 53
Waxwing, Cedar, 291, 295, 438
Webster, J. Dan., a revision of the Botteri sparrow, 136
Whale-bird, Slender-billed, 158
Whimbrel, 367
Whip-poor-will, 207
Ridgway, 206–209
Spot-tailed, 207
Whitaker, Lovie M., cave swallow nesting in building near Cuatro Ciénegas, Coahuila, México, 369
Willet, 284
Williamson, Francis S. L., a review of the birds of Alaska, by Gabrielson and Lincoln, 229
Williamson, Francis, S. L., and Peyton, Leonard J., breeding record of the double-crested cormorant in south-central Alaska, 154
Wilsonia pusilla, 53, 292
pusilla chryseola, 292
Woodhewer, Ivory-billed, 327
Olivaceous, 327
Streaked-headed, 328
Tawny-winged, 327
Woodpecker, Acorn, 76–77, 81
Black, 377, 378, 379, 387
Black-backed, 303
Chestnut, 328
Downy, 165, 287, 295, 379, 438
Gila, 58, 192, 204, 215, 286, 406, 435
Golden-fronted, 216, 329–330
Guatemalan Ivory-billed, 328
Hairy, 286, 379
Ivory-billed, 378
Ladder-backed, 216, 287, 398, 402, 404, 407
Lewis, 149, 286
Pale-billed, 52
Pileated, 377–387
Pucheran, 330
Red-bellied, 385, 386
Red-capped Green, 330
Red-headed, 371–372
Smoky-brown, 330
Tropical Pileated, 328, 334
Wren, Banded-backed, 330, 334
Bewick, 218, 399, 404
Cactus, 186–205, 218, 289, 295, 398, 399, 401, 402, 404
Canyon, 218, 289, 403
Long-billed Marsh, 100
Rock, 218, 289, 403
Sinaloa, 218
Southern House, 330
Spotted, 218
Spotted-breasted, 329
White-breasted Wood, 327
Winter, 230
Wrentit, 38–45, 53
Wright, Philip L., Hoffmann, Robert S., and Hand, Ralph L., recent bird records from western Montana, 147

X

Xanthocephalus xanthocephalus, 174, 292
Xema sabini, 148
Xenops minutus, 327
minutus mexicanus, 336
Xiphorhynchus flavigaster, 327–328
flavigaster eburneirostris, 336

Y

Yellowlegs, Greater, 163, 284
Lesser, 163, 173, 284
Yocom, Charles F., migration of starlings into the coastal region of northwestern California, 301
Yoshii, M., Okada, Y., Scherer, W. F., and McClure, H. Elliott, a method for determining age of nestling herons in Japan, 30

Z

Zenaida asiatica, 213, 285, 404
Zenaidura macroura, 285, 404
Zonotrichia, 315, 345, 347
albicollis, 55, 295, 316, 318
atricapilla, 53, 295, 344–345
capensis, 344–347
coronata, 344
leucophrys, 55, 96–109, 151, 276, 294, 344–345, 364–365
leucophrys gambeli, 151
leucophrys gambelii, 151, 315–324
leucophrys leucophrys, 151
leucophrys nuttalli, 96, 107
leucophrys oriantha, 151
petenica, 144
querula, 55, 151
Zusi, Richard L., fishing rates in the black skimmer, 298

***For Sale, Exchange, and Want Column*—Each member of the Cooper Society is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line. Send advertising copy to Jack C. von Bloeker, Jr., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.**

CHRISTMAS BINOCULAR SPECIAL—7 × 35, center focus, $27.75 (plus 10% tax)—importer's price $41.50—and OURS, of course, has been PRE-SERVICED by us! All defectives returned to importer; each sold shock-tested, loose parts fastened, and alignment adjusted to 1/1000. Like everything we sell, each has our famous FREE-SERVICE GUARANTEE. Our catalog includes Bausch & Lomb, and complete line of finest Japanese binoculars, with 6 models specially adapted by us for bird watching. Also, Bausch & Lomb and Bushnell 'scopes with threaded boss (made by us) for mounting 'scope directly on tripod, plus shoulder carrying strap, wide field 20x eye-piece giving 100 per cent more viewing area, and accurate rotating turret. All instruments postpaid on 30-day trial; Christmas gifts on trial until January 10, 1960. (If ordered after Dec. 1, 1959, request Special Handling shipment at our expense.) Send for catalog and copy of "Know Your Binoculars" reprinting our article published in Audubon Magazine, 10¢—no charge to COS members.—THE REICHERTS, *Mirakel Optical Co., Mount Vernon 15, N. Y.*

WANTED—Young man with training in systematic zoology to fill a permanent full-time position as Museum Zoologist. Duties include cataloguing, preparation and care of bird and mammal specimens; cataloguing and preparation of fossil vertebrates; and field work. No teaching or research will be involved. Required education and experience: Either, (1) a master's degree plus one year of experience; or, (2) a bachelor's degree plus two years of experience. Starting salary: $4,980.00 per annum. If interested, address inquiries to: Chairman, Dept. Zoology, Univ. California, Los Angeles 24, Calif.—DR. THOMAS R. HOWELL, *Dept. Zoology, UCLA, Los Angeles 24, Calif.*

SPECIMEN CABINETS—Write for complete details and specifications on Specimen Case no. 112, designed by the University of California, size 27″×44″×42″—priced at $199.00, F.O.B., Escondido, Calif.—CHAPPELL'S HOUSE OF WOODCRAFT, *Box 1085, Escondido, Calif.*

WANTED—Bull. Cooper Ornithological Club, vol. 1, nos. 3–4; Condor, vol. 2, no. 6, and vol. 3, no. 2. Will buy any one, two, three, or all four copies.—JACK C. VON BLOEKER, JR., *Los Angeles City College, Los Angeles 29, Calif.*

WANTED—Summer records of the Harlequin Duck. The distribution of this duck is not known in detail. M. T. Myres earnestly requests that readers of the Condor who have observed this species on a river, creek, or lake communicate with him. Any inland summer record will likely be of interest. Address % THE EDWARD GREY INSTITUTE OF FIELD ORNITHOLOGY, *Botanic Garden, Oxford, England*

CONTENTS OF RECENT ISSUES OF THE CONDOR

September-October, 1959

Observations on Salt Balance and Behavior of Laysan and Black-footed Albatrosses in Captivity.....*Hubert Frings* and *Mable Frings*

Premigratory Changes in Body Weight and Fat in Wild and Captive Male White-crowned Sparrows.....*James R. King* and *Donald S. Farner*

Avifauna of the Catemaco Basin of Southern Veracruz, México
Ernest P. Edwards and *Richard E. Tashian*

A Condor from the Upper Pliocene of Kansas.....*Harrison B. Tordoff*

Response to Experimental Light Increments by Andean Sparrows from an Equatorial Area.....*Alden H. Miller*

Change in Body Weight Associated with Onset of Ovarian Recrudescence and Oviposition in Pheasants.....*Clarence L. Nagra* and *Irven O. Buss*

Habitat Distribution of Birds Breeding Along the Upper Kaolak River, Northern Alaska.....*William J. Maher*

July-August, 1959

Numbers, Breeding Schedule, and Territoriality in Pectoral Sandpipers of Northern Alaska.....*Frank A. Pitelka*

Observations on the Cattle Egret in Colombia.....*F. C. Lehmann V.*

Liver Lipids in Hummingbirds.....*Frank A. Hartman* and *Katharine A. Brownell*

Notes on the Occurrence of Birds in Southern Nevada
Gordon W. Gullion, Warren M. Pulich and *Fred G. Evenden*

May-June, 1959

Aggressive Behavior in Migrant Pectoral Sandpipers.....*William J. Hamilton III*

Further Experiments on Torpidity in the Poor-will
Thomas R. Howell and *George A. Bartholomew*

Life History of the Cactus Wren. Part II: The Beginning of Nesting
Anders H. Anderson and *Anne Anderson*

The Ridgway Whip-poor-will and Its Associated Avifauna in Southwestern New Mexico.....*Richard F. Johnston* and *John William Hardy*

The Avifauna of the Barranca de Oblatos, Jalisco, México
Robert K. Selander and *Donald R. Giller*

March-April, 1959

Life History of the Blue Ground Dove.....*Alexander F. Skutch*

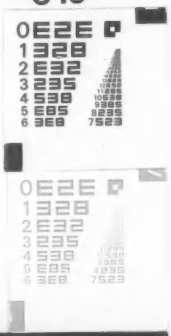
The Sierra Madrean Element of the Avifauna of the Cape District, Baja California
John Davis

Variability in the Electrophoretic Patterns of Avian Serum Proteins
Charles G. Sibley and *Paul A. Johnsgard*

Development of Nestling White-crowned Sparrows in Central Coastal California
Richard C. Banks

The Winter Society of the Oregon Junco: Intolerance, Dominance, and the Pecking Order.....*Winifred S. Sabine*

A Revision of the Botteri Sparrow.....*J. Dan Webster*

Recent Bird Records from Western Montana
Robert S. Hoffmann, Ralph L. Hand, and *Philip L. Wright*

C15